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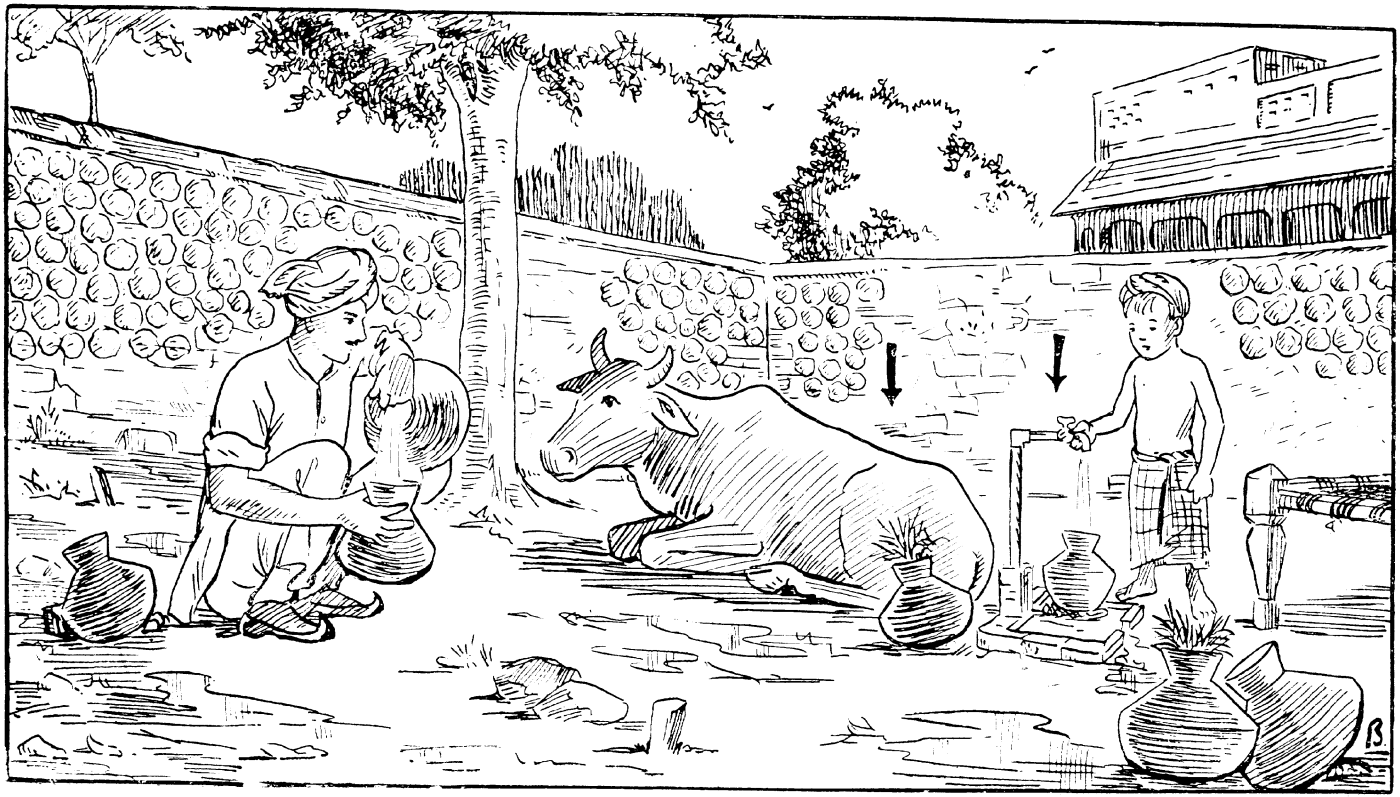

'Sources' of Lahore Milk Supply.

The Board of Economic Inquiry, Punjab.

RURAL SECTION PUBLICATION.—28.

[General Editor : J. W. THOMAS, B.Sc., B.Com.].

THE MILK SUPPLY

OF

LAHORE

1930.

INQUIRY

CONDUCTED BY

ROSHAN LAL ANAND, M.A.,

UNDER THE SUPERVISION OF

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[The Board of Economic Inquiry, Punjab, does not hold itself responsible for any opinions expressed or conclusions reached by the writers.]

1933.

The milk business is neither the gujar's or the gowala's, nor the halwai's, nor yet the consumer's ; it is the community's business, and unless members of the community work together for pure, wholesome and clean milk, they will never get it. At present the general public has no more than a grumbling interest in the problem.

PREFACE.

This report on the Milk Supply of Lahore in 1930 is the fourth and most comprehensive in the series on milk problems published by the Board of Economic Inquiry, Punjab. The first report was a similar inquiry conducted in Lahore in 1921, but in view of the changes that have since taken place due to the rapid growth of Lahore and the difficulties experienced in securing a better and more hygienic milk supply it was felt advisable to make a more thorough investigation of the problem. The other two reports deal with the town of Lyallpur, one being a preliminary survey of its milk supply in 1927 and the other a study of the cost of milk production made in 1930-31. The latter subject is of some importance and it is hoped that before long data will be available for publication concerning this subject as it affects Lahore.

The present inquiry was conducted during the first ten months of 1930 by Mr. Roshan Lal Anand, M.A., an investigator of the Board under the supervision of Prof. A. C. Aggarwala, B.Sc., of the Punjab Veterinary College, Lahore, and assisted for a time by Mr. P. D. Punj, I.D.D. The report relates to the Lahore Municipal area only, the population of which at the 1931 census was 400,075. The daily milk supply was estimated at 1,207 maunds and of this half came from outside the municipal area from villages within a radius of about 30 miles. This gives a *per capita* milk consumption of a little less than four ounces—a much lower figure than is found in the case of large cities in other countries and, inasmuch as a considerable section of the people of Lahore are vegetarians, milk should be an important part of their diet. A study of the milk used by about 1,000 families showed that it is a luxury outside the reach of the masses but that in the case of families with incomes of over Rs. 500/- per month the average consumption is high compared with other countries. The trend of milk prices during the past 25 years follows in general the trend in the prices of food grains, moving up until 1921 and then a gradual fall in sympathy with the general price level.

This report again emphasises what was said in the Preface of the previous report of the Milk Supply of Lahore in 1921, from which we quote as follows :—

> " Underfed cattle are housed under most insanitary conditions ; milkers have no conception of personal cleanliness ; the milk is transported under conditions favourable to contamination with dust and dirt, the usual method being an open mouthed brass receptacle plugged with grass or straw carried by open cart or pack transport ; the milk is adulterated and sophisticated according to the whim of the various vendors, the fluid which finally reaches the consumer not infrequently containing a sample of the nearest drain in addition to ordinary dust and dirt.
>
> " In fact the milk supply of towns has been allowed to develop haphazard without any official attempt at regulation."

Unfortunately conditions have remained much the same since the above was written ; and no public interest in this vital matter has been displayed. The information collected shows that in the last decade there has not been any improvement either in the relative quantity or quality of the milk supply in such an important market as Lahore. Mr. Roshan Lal's figures with regard to the cost of transport are for *tum-tum* (horse-cart) between one anna six pies and two annas three pies per maund of milk per mile, pack-horses three annas three pies whereas lorries charge 7 pies per maund per mile and yet only 60 maunds out of a total of 613 maunds of milk are carried in this manner.

This report includes fresh material with regard to the disposal of milk in the retail market of Lahore. The major portion of the milk is disposed of by small shopkeepers, who secure their supply by a system of yearly fixed contracts or according to the current market rates. This entire retail market shows very little organization or specialisation, and the whole function could be described as antiquated.

One cannot but give his imagination some liberty when reading the account concerning the village of Handu. If a co-operative dairy farm owning several thousand acres of land with proper lorry transport and distributing stations in Lahore could be organised a considerable change both in the economic conditions of such a village as well as in the supply of milk in Lahore could be effected. There has been no attempt in this report to study the *ghi* problem or the question affecting the supply of other milk products such as cream and butter. The very high infant mortality in Lahore is undoubtedly connected with the lack of a proper milk supply. It may reasonably be hoped that public interest will be aroused by this survey of the main facts regarding the milk supply of Lahore.

Acknowledgment is due to Prof. Aggarwala, who closely supervised the inquiry and gave much of his leisure to revising the data and to his laboratory assistant, Mr. Abdul Wahid Khan, and to some senior students of the Veterinary College who gathered records of milk imports on two occasions and analysed milk samples, as well as to Capt. B. B. Kapila, M.B., Ch.B., Municipal Medical Officer of Health and his staff for valuable co-operation.

E. D. LUCAS,

Dated 8th January, 1933.

ACTING SECRETARY,

Board of Economic Inquiry, Punjab.

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CHAPTER I.

HISTORICAL.

Lahore, the capital of the Punjab and one of the largest towns in India, lies in latitude 31° 35′ N. and longitude 74° 20′ E., and is situated near the left bank of the river Ravi. The climate, though healthy for the most part of the year, is characterized by considerable changes, a maximum of 117° F. in June and a minimum of 32° F. in January being quite normal ; the difference between the maximum and the minimum temperatures recorded in a twenty-four hour period ranges between 30° to 40° F. from October to March and some 20° to 30° F. in the remaining months. The preservation and storage of milk presents many difficulties in the protracted hot season, and generally speaking it is a problem that is yet to be solved.

The present inquiry was limited to the Municipal area of about 26 square miles ; the old walled city proper covers about a square mile and civil station 25 square miles. The population at the 1931 census was 400,075, which gives an average of 15,387 persons per square mile : the intramural area is extremely congested. Lahore is a big educational centre with some fifteen colleges and twice this number of schools ; besides workers in small factories, about ten thousand workmen are employed in the workshops of the North Western Railway, which have their headquarters here.

The foregoing facts would suggest that the milk supply would have received much public attention. Unfortunately that has not been the case ; the past efforts at improving the milk supply are not a credit to Lahore, much less so when the city happens to be the metropolis of a Province. In what follows an attempt has been made to present a study of the local milk supply by putting together all the facts now available.

The first Annual Report of the Lahore Municipal Health Department was published in 1910, and since then similar reports have continued to appear annually. These reports in which passing references have occasionally been made to milk questions, and the files of the local Health Department are the chief sources of information in this connection.

In the first issue of the Annual Report of the Health Department it is mentioned that milk licenses were introduced in the Civil Station (as opposed to the city proper, encompassed by the city walls) on 8th July, 1909. " But," the report complains, " until we have a laboratory, no kind

of license can be kept up to its conditions and so the present licenses degenerate into mere registration." Besides the necessity for a laboratory, it was also urged that the milk vendors of the city should be brought within the purview of the license. The Health Officer also showed the dangers accompanying the admixture of goat's milk with cow's milk—a practice quite common even now. He pointed out that goat's milk was liable to cause Malta fever, if the goat be so affected.

In the second Annual Report (1911) Dr. Newell, the then Health Officer, traced the part played by milk in the dissemination of pulmonary tuberculosis. "To the milk supply," he said, "we must ascribe a more important source of danger. . . . One thing, however, is certain that the tubercular bacillus can develop and pass through the excreta of a cow, even though the cow is not affected with tuberculosis. I am rather of opinion that more tuberculosis is passed in India through cow-dung and cow-dung cakes than through the medium of milk. This may appear at first a startling statement to make, but our veterinary examinations have shown that tuberculosis, both in cows and buffaloes, is a rare disease." He further added that the importance of milk as a cause of tuberculosis was reduced by the prevalent custom of taking boiled milk. In view of the above he made the following recommendations :—

(*a*). Registration, if possible against a small fee, of all the cattle in the city. Free registration, he thought, would be no good.

(*b*). Construction of cattle sheds in some of the wards, which should pay their own way. The idea of this recommendation was in due course to prohibit the keeping of cattle within the houses; a practice which constitutes a menace to the health of the people living there.

(*c*). Opening municipal milk shops to supply pure milk to the public.

In 1912 a special sub-committee appointed for the purpose made the following recommendations to the general committee, all of which were passed with the exception of the fourth :—

(1). to enforce section 150 of the Municipal Act ;*

(2). to erect a laboratory for the analysis of milk, etc.;

(3). to reduce octroi charges on milk ;

(4). to appoint a food inspector ; and

(5). to award prizes to dairies which carried out the sanitary requirements satisfactorily.

* "Penalty for selling food or drink not of the nature, substance or quality of the article demanded by the purchaser."

By 1916 the bye-laws for licensing the premises where milk was sold were introduced within the city proper also. The Medical Officer of Health in his report for that year suggested the following points to increase the supply of pure milk :—

(1). Removing the *gujars* from within the city and providing them with suitable accommodation in close proximity to the city.

(2). Running a Municipal Dairy and developing a municipal milk supply under sanitary conditions.

A commendable movement was started in the latter half of 1920 by the residents of Kucha Babian (a lane in the city) to improve the conditions of the city milk supply. With this aim in view they formed a committee which enlisted honorary volunteers to inspect the premises of *gujars* and shops of *halwais* (milk vendors) and to educate the public in the importance and necessity of obtaining a supply of clean milk. The line of action of this committee, as ascertained from the files in the Municipal Office, is given in the footnote.* No further account of the activities of this group is traceable from any source, and soon afterwards the committee must have ceased to exist. However, it did supply some food for thought to the city fathers who appointed a sub-committee to report on the subject. The task was ultimately delegated to Dr. Gopi Chand Bhargava. The following are the more important observations and recommendations in his report :—

1. Milk could only be improved by controlling its supply both to the public and the milk sellers . . . Licences should be enforced on the *gujars* also . . . Unless a pure supply was ensured the license of the milk sellers was not of much use.

2. In the absence of a municipal dairy, arrangements should be made to collect milk from the neighbouring villages and to supply it to the milk sellers.

---

*1. The honorary volunteers (of the committee) be allowed to work in conjunction with the Sanitary Inspectors, as the number of the latter was too small to cope with the work of milk inspection of the city.

2. The (Municipal) Inspectors be required to inspect milk both in the morning and evening as opposed to the then existing arrangement of devoting only the morning hours to the work.

3. The habitual sellers of adulterated milk be given exemplary punishment, *e.g.*, confiscation of license for some period, holding that the mere imposition of a fine did not have a sufficient deterrent effect.

4. An effective control be exercised over the sale price of milk.

5. The milk sellers be required to hang on the walls of their shops the results of the chemical analyses of milk done by the municipal staff.

6. To arrange for another laboratory inside the city proper to enable the public to get doubtful milk tested.

3. To prohibit the *gujars* from feeding their cattle on deleterious diet, section 148* of the Municipal Code should be brought into force.
4. The sale of skimmed milk should be brought under control.
5. Milch cattle kept inside the city should be examined by veterinary assistants, provided honest men were procurable.
6. Arrangements should be made with the Forest Department, or ground should be rented near the city to serve as grazing ground for the city cattle.
7. Honorary volunteers, if forthcoming from respectable classes, should be empowered to take samples of milk and to appear in court as the Sanitary Inspectors do.
8. The various abuses connected with the licenses should be removed.

On the strength of this report the Lahore Municipality decided in its meeting held on the 24th September, 1921, to enjoin the shopkeepers selling skimmed milk to put up a signboard to this effect, and to correspond with the Minister of Agriculture requesting the Government to set apart land in the neighbourhood of Lahore Municipality for pasturage on payment by the *gujars*. This desire of the Committee could not be acceded to by Government as all the *rakhs* (forest reserves) within a radius of 10 miles of Lahore had been earmarked.

The proposal to create a large dairy farm in the vicinity of Lahore has a long history behind it. The following material taken from page 44 of Shiva Datta's "*A Paper on the Milk Supply of Lahore in 1921*,"† had been gathered from the records of the Darogha, Nuzul Lands, Lahore.

"In March 1909 five gentlemen under the lead of a European dairy expert applied for a plot of land measuring from two to three thousand acres situated within easy reach of Lahore for (*a*) grazing milch cattle, (*b*) raising fodder for them, and (*c*) housing them. They offered to form a limited company for supplying pure milk and butter to Lahore, especially to the European population. In response to this and for the benefit of any further applicants, Government decided to set apart for this purpose a plot of 1,846 acres called 'Rakh Chandrai,' about 12 miles away from Lahore. For irrigating this land, a *rajbaha* passed across its whole length. Owing, however, to the early demise of the European expert, the scheme fell through.

---

* "Feeding animals on deleterious substances."

† Published by the Board of Economic Inquiry, Punjab, as Rural Section Publication No. 2, and now replaced by this volume.

" In 1913, the Lahore Municipality resolved to raise a loan of a lakh of rupees for the purpose of starting a model dairy farm near Lahore. They recognised, however, that it would be much better to leave such an enterprise to be made by some private agency and further appealed to Government for the provision of grazing at nominal or concession rates.

" In supersession of this, but following the spirit of the resolution, a Syndicate called the ' Lahore Dairy Syndicate ' consisting of four well-to-do citizens of Lahore was formed in 1913, and after considerable correspondence Rakh Chandrai was leased out to them on certain conditions and they began work in 1915. The objects of this syndicate were in substance the same as those of the applicants of 1909, but it failed to fulfil the conditions of the lease prescribed by Government, mainly owing to the fact that they got practically no canal water for irrigating their lands. Accordingly, in 1919 Government resumed possession of the lands. On the termination of this lease in 1920, it was sought to secure the land again for dairy purposes. The following were the chief proposals :—

(*i*). Certain individuals offered to run a dairy on a large scale.

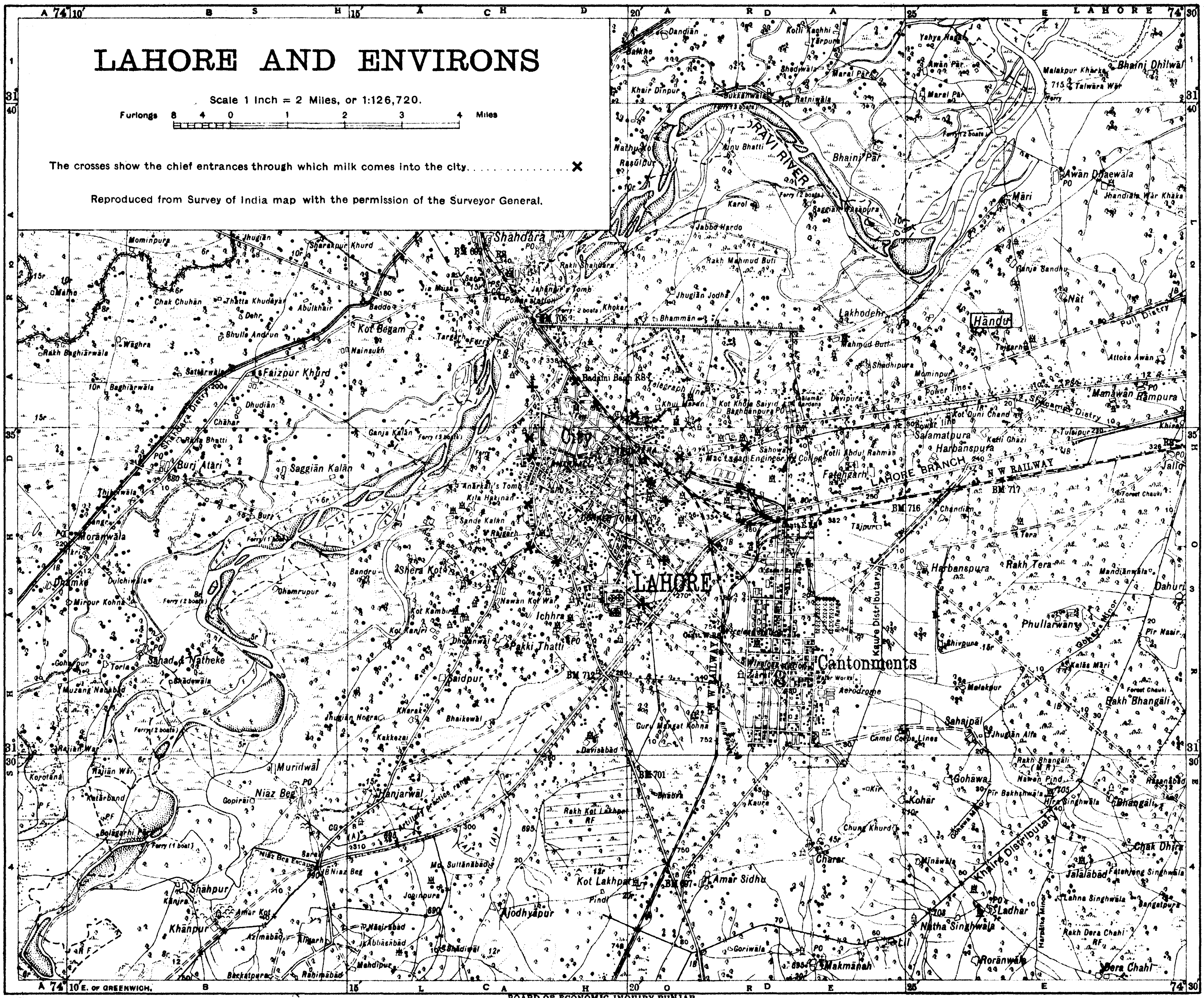
(*ii*). Certain individuals offered to run a dairy on a co-operative basis.

(*iii*). A proposal to open a joint dairy farm for schools and colleges, under supervision of a Committee of their heads.

(*iv*). A proposal to start a dairy under the general charge of the Principal, Veterinary College, and under the direct supervision of a European, to serve as a model for veterinary students and to supply good milk and butter for college and school boarders. In this connection a rough estimate of the cost of a dairy consisting of 200 cows in full milk was added by Colonel Walker, Principal, Punjab Veterinary College, Lahore."

The lease of Rakh Chandrai was, however, given to two experienced dairy farmers but they also failed to make any profitable use of it and the scheme soon fell through.

The resolutions of the Municipality passed in 1913 have already been referred to, and, in accordance with their resolution of the 9th October, 1920, they—(*a*). prohibited the slaughter of milch cows and calves within municipal limits, and (*b*). requested Government to sanction 100 squares of land near Lahore, ' for rearing and grazing milch cattle and for the establishment of a municipal dairy to meet the growing demand of the people for a supply of milk at cheaper rates than at present.' Unfortunately the demand



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for the 100 squares of land was not acceded to, but Government encouraged the Committee to prepare a definite scheme for its consideration. This was done by a dairy expert and cost the Committee a considerable sum. When, however, the scheme was referred to the Public Health Sub-Committee on the 14th February, 1928, it met with great opposition and the verdict was given that ' the model dairy farm proposed by the Municipality was not practicable.' Instead the Sub-Committee recommended that ' model cow-sheds be built by the Municipal Committee in suitable places to be given out on rent.' The Medical Officer of Health accordingly selected ten sites for the purpose and framed further recommendations for the consideration of the Committee. These were :—

(*a*). To license the importers of milk;

(*b*). to fix the hours of import of milk in order to bring the imported milk under effective control;

(*c*). to empower the Sanitary Inspectors to destroy such milk as they thought to be unfit for human consumption ; and

(*d*). to approach Government to appoint a special magistrate to deal with cases of adulteration without delay; the court to be requested to effect exemplary punishment on the offence.

These recommendations along with the list of sites selected were presented to the Sub-Committee, which after a few meetings decided to dissolve and to request the President to take such action as he thought fit. There the whole thing ended.

This narrative would indicate that the problem of securing an ample and wholesome supply of milk for the city of Lahore is intricate, and the steps to solve it have been spasmodic and half-hearted, with the result that little or nothing has been done so far to put the supply on a more satisfactory basis.

CHAPTER II.

SUPPLY OF MILK.

The city of Lahore draws its supply of milk from two sources: external, *i.e.*, places outside the Lahore Municipal limits; and internal, *i.e.*, the Lahore Municipal area.

I.—The External Sources of Milk Supply.

With the replacement of the octroi duty by the terminal tax in 1925, the import of milk into the city was made duty free. Consequently no records of the daily imports of milk are now kept by the Terminal Tax Department. An independent inquiry, therefore, was conducted on the 2nd February, 1930, with the help of a contingent of about fifty students of the local Punjab Veterinary College. The seventeen entrances to the city were watched from 6-0 a.m. to 10-0 p.m. by groups of students and the necessary information taken from persons bringing milk into Lahore was recorded according to a schedule of questions drawn up for the purpose. (See Appendix D.).

Later, it was noticed that, as milk was duty free, quite an appreciable amount came in through the many short-cuts, besides the entrances recognised by the Terminal Tax Department. Therefore, it was considered advisable to repeat the investigation in the light of the experience gained in the first attempt. This was done on the 5th October, 1930, and the results obtained were more satisfactory. Milk imports as recorded on 2nd February, 1930, amounted to 419 maunds, 25 seers, and those recorded on the 5th October, 1930, amounted to 613 maunds, 9 seers. The great increase in the import records in the second case is due mostly to the more effective watching of all the possible entrances to the city, more efficient working by the students and more enlightened supervision. Only the figures obtained in the second inquiry have been included in this report, but at places references have also been made to the figures obtained at the first attempt.

The following table shows the quantity of milk imported into the city on the 5th October, 1930, along with the number of persons directly

engaged in its transport :—

Details of Milk brought into Lahore on 5th October, 1930.

Name of terminal tax post.	Cow's milk.	Buffalo's milk.	Goat's milk.	Camel's milk.	Mixed milk.	Total.	No. of persons engaged in transport.*
	Mds. Srs.	Mds. Srs.	Mds. Srs.	Mds. Srs.	Mds. Srs.	Mds. Srs.	
Lahore Railway Station..	12 22	47 18	..	1 13	1 1	62 14	32
Sultanpura ..	2 32	1 0	0 10	..	..	4 2	6
Shalamar Bagh Road ..	9 29	32 25	..	..	53 28	96 2	47
Garhi Shahu ..	21 20	55 14	..	..	8 18	85 12	45
Race Course Road ..	4 26	9 6	..	..	..	13 32	9
Ferozepore Road ..	27 2	77 25	0 19	..	17 33	122 39	43
Chauburji ..	18 28	33 5	2 34	..	21 37	76 24	36
Raj Garh ..	2 36	0 30	..	0 12	3 30	7 28	13
Tapp Road ..	0 6	..	..	0 10	..	0 16	2
Data Ganj Baksh ..	1 10	3 34	..	4 27	2 20	12 11	13
Ravi Road ..	30 5	42 20	0 19	0 19	8 24	82 7	41
Badami Bagh ..	..	2 38	..	..	..	2 38	3
Badami Bagh Malgodam	0 35	1 39	..	..	..	2 34	5
Chah Miran ..	3 30	12 1	..	..	..	15 31	12
Ways other than terminal tax posts ..	22 13	5 20	0 6	..	..	27 39	10
Total ..	*158 14*	*325 35*	*4 8*	*7 1*	*117 31*	*613 9*	*317*
Percentage ..	*25·8*	*53·1*	*0·8*	*1·1*	*19·2*	*100·0*	..

NOTE.—2 maunds 32 seers of *khoya* (desiccated milk) and 65 lbs. of butter were also imported.

Generally speaking, 'mixed milk' is a mixture of cow and buffalo milk, but, in numerous instances it also contained goat, sheep and even camel milk.

Ferozepore Road, Shalamar Bagh Road, Garhi Shahu, Ravi Road and Chauburji are the chief entrances through which more than three-fourths of the external milk supply finds its way into the city.

*Refers to persons who actually brought milk for sale, excluding tongawalas and drivers of other vehicles.

Some Estimates of the Daily Imports of Milk.

Investigations could not be repeated during the various parts of the year so as to trace the influence of various factors concerned in the import of milk. Nor is it possible, owing to the absence of any records on the subject, to trace the trend of progress of this side of the milk trade of Lahore during the last decade. However, some estimates of the quantities imported into the city have been prepared from time to time which it may not be out of place to give here. An actual census taken in May, 1916,* showed that 30,318 lbs. of milk (about 370 maunds) was daily brought from outside. According to an estimate made by the Octroi Department of the Lahore Municipality, 350 maunds of milk were imported during the 24 hours ending 15th April, 1921.†

The exemption of milk from terminal tax meant a diminution in the revenues of the Municipality, and the correspondence between the Municipal Department and the Punjab Government—the former urging its re-imposition (at Rs. 0/1/0 per maund) and the latter opposing the idea—is both interesting and valuable; this must be our apology for giving rather long extracts from the official files on the subject.

A resolution was passed on the 9th January 1926 at a special meeting of the General Committee of the Lahore Municipality which runs as follows :—

" Resolved that as no reduction in the price of milk has taken place owing to its exemption from the levy of the Terminal Tax, and as it would be inadvisable to forego on sentimental grounds the imposition of the tax considering the decent income which accrued to the Committee from octroi, Government be approached to allow the Committee to levy it again at the proposed rate of one anna per maund."

Mr. C. M. G. Ogilvie, the then Deputy Commissioner of Lahore, returned this resolution to the Municipal Committee, Lahore, for reconsideration with the remark that " the reason given is that the exemption has not had the desired effect of lowering the price of milk. This is true no doubt, and, moreover, the supply of milk has not been purer. But at the same time we should not overlook the fact that the reduction of Rs. 0/1/0 per maund cannot produce the desired effect." " The Government might consider," he added, " the trouble and embarrassment to which the importers of milk would be subjected—an objectionable feature, as they

*" Notes on Dairying," by Bhai Kartar Singh, p. 2.

†" A Paper on the Milk Supply of Lahore in 1921," by Shiva Datta, p. 1.

would have to wait at the barriers for the payment of the tax and a comparatively small amount would be realized in return." He further asked the Municipal Committee how much they expected from this taxation.

Accordingly the Municipal Committee submitted an estimate which says—

"During the period of Octroi system milk was chargeable at Rs. 0/1/3 per maund and yielded an average revenue of Rs. 100/- per day, *i.e.*, Rs. 36,000/- per annum. But now the rate of the same is proposed to be at Rs. 0/1/0 per maund, which rate is likely to reduce the income of Terminal Tax to Rs. 30,000/- per annum."

This estimate was forwarded by the Deputy Commissioner, Lahore, to the Commissioner, Lahore Division. The Commissioner in his letter, dated 28th July, 1926, to the Deputy Commissioner commented on the estimate presented in the following words :—

"My information is that when octroi was charged, the daily import of milk averaged 350 maunds, which would bring in only about a quarter of the income estimated by the Committee.

"Even so the income is not inconsiderable. But I would ask the Committee to consider the advisability of imposing at the same time a tax on milch-cattle kept within municipal limits both by *gujars* and privately. It is very doubtful whether cattle should be allowed to be kept at all in a city, considering the grave insanitary inconveniences which their retention causes. It is certainly inequitable that milk supplied from them should be untaxed while imported milk which is attended by no inconvenience should be taxed.

"It should be added that the proposed tax, though only reimposed will probably be shifted on to the consumer and cause some increase in the cost of milk."

It is probable that in the estimate referred to above, not only milk but milk products, all of which come under one class of goods, were also included by mistake. The Terminal Tax Superintendent then worked out the figures again and put down the revised estimate at Rs. 9,000/- per annum, which at Rs. 0/1/0 per maund means an average daily import of 396 maunds of milk.

The exact income from milk to the Lahore Municipality from 1st January to 31st December, 1924, was Rs. 15,471/-,* according to which the daily import averaged 543 maunds.

Another figure is also given in this correspondence, arrived at by calculating the imports of milk on the 15th day of every month for 1924, which amounted to 484 maunds, 33 seers.

**Vide.* Terminal Tax Superintendent's Report for 1924-25.

Communities importing milk.—The total number of persons who severally imported milk on the 5th October, 1930, was 317; nine-tenths of these were Mohammedans. The following are the details regarding their castes :—

		No. of persons.
I.	*Mohammedans*—	
	Gujars	134
	Telis	33
	Jats	25
	Rajputs	18
	Arains	15
	Mochis	11
	Balochs	6
	Jogis	3
	Changars	3
	Pathans	2
	Sheikhs	2
	Kashmiris	1
	Dhobis	1
	Moghals	1
	Sayeds	1
	Others	28
	Total ..	*284*
II.	*Hindus*—	
	Aroras	12
	Khatris	5
	Gowalas	2
	Rajputs	1
	Total ..	*20*
III.	*Sikhs*—	
	Jats	10
	Mehras	1
	Total ..	*11*
IV.	*Christians*	*2*
	GRAND TOTAL ..	*317*

Milk carried per person.—The average load of milk per man was 1 maund, 35 seers. Persons carrying less than 20 seers of milk were most numerous ; they were *zemindars* living in the vicinity of the city who were producing milk above their domestic requirements. Those carrying between one and two maunds came next in number. However, the dispersion from this mean is very wide, the two extremes being 3 seers and 16 maunds 10 seers. In the following table importers of milk have been classified according to the amount of milk brought by each person :—

Quantity of milk carried.	*Number of persons carrying this quantity.*
Up to 20 seers	83
From—	
20 seers to 1 maund	44
1 maund to 2 maunds	71
2 maunds to 3 „	40
3 „ to 4 „	43
4 „ to 5 „	23
5 „ to 6 „	5
6 „ to 7 „	4
7 „ to 8 „	0
8 „ to 9 „	1
Above 9 maunds	3

Producers and Middlemen.—A person who takes milk to the city either brings the milk produced by his own cattle, when we may call him a 'producer,' or he buys small quantities from a number of families in his neighbourhood and then may be called a 'middleman,' since he is acting as an intermediary between the village milch-cattle keepers and the city retailers. This distinction fails at times since the same person may be both a 'producer' and a 'middleman.' However, the terms used have an indicative value.

Of the 317 persons engaged in the transport of milk, 161 were 'middlemen,' bringing in very little milk of their own ; the remaining 156 were 'producers.' The total amount imported by the 'middlemen' was 402 maunds, 4 seers as compared with 211 maunds, 5 seers imported by 'producers' ; the former on an average brought twice as much as the latter.

Further, the range of the producer was narrow, as compared with that of the middleman. 57 per cent. of the producers imported milk from within a radius of four miles, 24 per cent. from four to eight miles, and 19 per cent. from more than eight miles. The corresponding figures for the middlemen are 29, 28 and 43 per cent., respectively. Information

gathered by a visit to Handu,* the village which sends the largest amount of milk to Lahore, shows that the middlemen are more prosperous than the producers; their task is lighter, their investments smaller and their chances of loss rarer. Above all, the middleman's transport cost is considerably less since he usually collects the milk from a number of families in one round, as against the individual arrangements of each producer.

Time of import of milk.—The following table shows the imports of milk during the various parts of the day on the 2nd February and 5th October, 1930 :—

Imports of Milk during Different Parts of the Day.

Time.	2nd February, 1930.		5th October, 1930.	
	Import.	Percentage.	Import.	Percentage.
	Mds. Srs.		Mds. Srs.	
Before 6 a. m.	..	..	6 25	1·2
Between—				
6 & 8 a. m.	11 23	2·8	71 30	12·2
8 & 10 a. m.	57 23	13·8	126 31	21·3
10 a. m. & 12 noon ..	182 27	43·5	256 19	43·0
12 noon & 2 p. m. ..	153 15	36·5	28 34	4·9
2 & 4 p. m.	4 30	1·1	2 15	0·4
4 & 6 p .m.	9 27	2·3	29 4	4·9
6 & 8 p. m.	..	..	70 32	11·9
8 & 10 p. m. ..	..	..	1 22	0·2
Total ..	*419 25*	*100·0*	*594 12*†	*100·0*

On the 2nd February, 1930, (and this is more or less true of the winter season also), 6 a.m. marked the commencement and 6 p.m. the termination of the daily imports; 10 a.m. to 2 p.m. were the busiest hours during which more than four-fifths of the milk came in; after 2 p. m. imports declined rather suddenly. The hours of business increase as the days become

* A description of the village Handu is given on page 21.

† Milk imported from the Lahore Cantonment Military Dairy Farm is not included in this table.

longer. On the 5th October, 1930, milk began to pour in even before 6 o'clock in the morning and the last man to cross the city boundary with milk came at 10 p.m. There was no absolute stoppage during these sixteen hours, but two definite busy periods can be discerned: one between 6 a.m. and 12 noon during which more than three-fourths of the total imports was made, and the second between 4 p. m. and 8 p. m. when the evening supply (about one-fifth of the daily imports) reached the city.

Distance of transport. Lahore draws its supply from about 65 villages. The following table shows the quantity imported from different distances:—

Table showing Distances from which Milk is Imported.

Distance.	2nd February, 1930.		5th October, 1930.	
	Import.	Percentage.	Import.	Percentage.
	Mds. Srs.		Mds. Srs.	
Less than 4 miles	105 33	25·2	149 0	24·3
From—				
4 to 8 miles	122 38	29·3	169 4	27·6
8 to 12 ,, ...	99 22	23·7	155 32	25·4
12 to 16 ,, ...	47 18	11·3	82 27	13·5
16 to 20 ,, ...	20 7	4·8	33 34	5·5
20 to 24 ,, ...	2 15	0·6	7 21	1·2
24 to 28 ,, ...	13 21	3·2	14 11	2·3
28 to 32 ,, ...	..	..	1 0	0·2
32 to 36 ,, ...	4 21	1·1	..	..
Above 36 ,, ...	3 10	0·8	..	..
Total ..	*419 25*	*100·0*	*613 9*	*100·0*

Both sets of figures lead to practically the same conclusion; *viz.*, about a quarter of the external supply comes from villages situated within a radius of 4 miles, and three-quarters from villages within a radius of 12 miles from city.

It is well known that as a city grows larger the suburban land becomes too valuable for anything but the most intensive forms of culti-

*In 1928-29 the maximum radius of milk supply was estimated at 330 miles for London, 120 for Glasgow, 200 for Berlin and Paris and 450 miles for New York, *Vide* 'Milk Price Margins' (Empire Marketing Board Publication No: 51).

Fig. 1. Transport of Milk by Tum-tum.
(The tum-tum carries more than three-fourths of the milk imported into Lahore.)

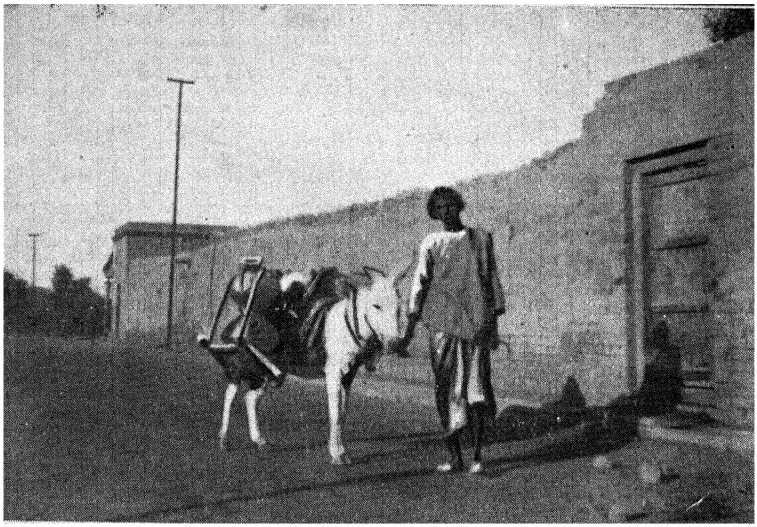


Fig. 2. Transport of Milk by Donkey.

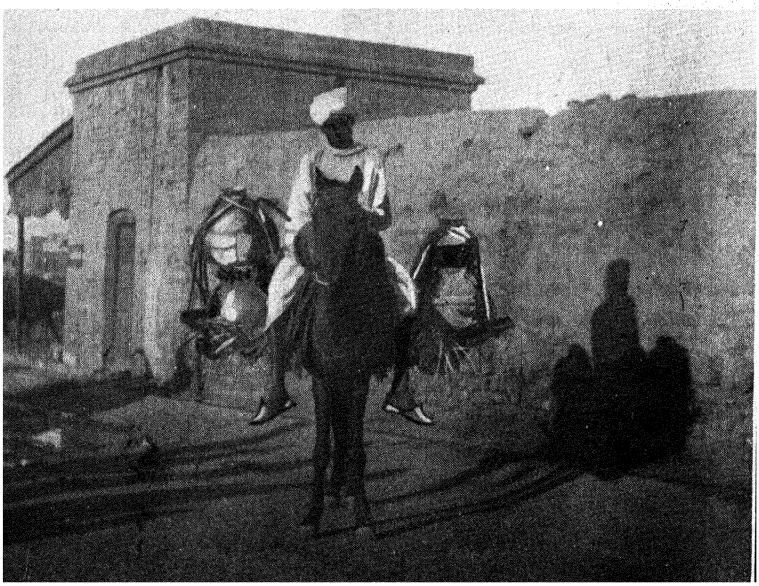


Fig. 3. Transport of Milk by Horse.

(The transport of milk by pack-animals with W-shaped wooden panniers, in which vessels are placed on either side, are gradually going out of use.)

vation, and dairy farms are pushed farther away from the centre of population. This tendency is noticeable in Lahore also, as the following figures show :—

Imports of Milk in Different Years from Different Distances.

	1921.* *Per cent.*	1930. *Per cent.*
From villages lying within-		
4 miles	27	24·3
4 to 12 miles	64	53·0
Over 12 ,, ...	9	22·7

In describing the condition of the Lahore milk supply in 1916, Bh. Kartar Singh says, " The city draws its supply from about 57 villages within a radius of 15 miles."†

Improvements in the condition of roads and the growing popularity of the motor lorry are probably responsible for this extension of the supply area ; this, however, is not very desirable after a certain limit is reached, unless better hygienic methods are adopted for transport and storage, especially during the summer season. The practice of keeping unsold milk overnight for sale the next day is fairly common amongst *gujars*, and is open to grave objections because no sanitary arrangements exist for the proper storage and preservation of the milk. They simply store it in uncovered and unclean brass *valtohis* in any available nook or corner of their dirty houses. The practice of keeping milk overnight is unavoidable in the case of villages situated at long distances from the city. On the 2nd February, 1930, 33 persons out of 76 (from the villages lying within 4 miles of the city) carried their milk twice. From villages lying between 4 to 8 miles, the number was 8 out of 48, and from the villages lying farther than 8 miles, only 3 out of 63 delivered milk twice.

Cow vs. Buffalo milk.—One interesting feature of the external milk supply is that the proportion between cow and buffalo milk varies with the distance of the village of origin from the city : the import of cow's milk as against buffalo's falls as the distance from Lahore increases. The only exception is in the case of imports on the 2nd February, 1930, from villages situated beyond 20 miles ; there is no such break in the corresponding figure for the 5th October. The table given on the next page shows the comparative imports of cow and buffalo milks according to distances from Lahore ; the milk of other animals and ' mixed milk ' have been excluded.

* " Milk Supply of Lahore, 1921," by Shiva Datta, p. 1.
† " Notes on Dairying," by Bh. Kartar Singh, p. 2.

Table showing Distances from which Cow's & Buffalo Milk is Imported.

Distance.	2nd February, 1930.			5th October, 1930.		
	Cow's milk.	Buffalo milk.	Proportion.	Cow's milk.	Buffalo milk.	Proportion.
	Mds. Srs.	Mds. Srs.		Mds. Srs.	Mds. Srs.	
Less than 4 miles ..	27 25	55 21	1 : 2·0	45 4	57 37	1 : 1·3
From 4 to 8 miles ..	22 25	53 19	1 : 2·4	45 11	90 7	1 : 2·0
,, 8 to 12 ,, ..	12 34	57 39	1 : 4·5	41 19	92 1	1 : 2·2
,, 12 to 16 ,, ..	3 18	30 10	1 : 8·9	19 10	52 24	1 : 2·7
,, 16 to 20 ,, ..	0 15	15 37	1 : 42·4	4 15	13 9	1 : 3·0
Above 20 miles ..	1 18	22 8	1 : 15·3	2 35	19 37	1 : 6·9

Means of transport.—The means of transport used in the milk trade, arranged in order of importance, are as follows :—

Table showing the Means of Transport.

Means of transport.	Amount of milk carried on—	
	2nd Feb. 1930.	5th Oct. 1930.*
	Mds. Srs.	Mds. Srs.
1. Tum-tum	340 12	449 26
2. Train	33 27	37 27
3. Motor lorry	24 13	60 6
4. Human being	11 5	21 5
5. Horse	8 35	22 6
6. Bicycle	1 13	3 2

*18 maunds, 37 seers of milk sent to Lahore by the Lahore Cantonment Military Dairy Farm are not included : much of this milk was, however, conveyed by tongas. Details are also lacking for another 20 seers.

The *tum-tum* (Fig. 1) is by far the most popular conveyance and accounts for more than three-fourths of the total imports. Its range extends roughly from 3 to 16 miles, beyond which it yields to the motor lorry and train. The more important railway stations that book milk to Lahore are Kot Lakhpat (9 miles), Atari (16 miles), Jia Bagga (19 miles), Raewind (25 miles) and Kot Radha Kishen (35 miles). The development of motor traffic is a new factor in the Punjab, and it has made the quick transport of milk possible over long distances in areas not served by the railway. The facilities provided by the lorry in contrast with the railway are that (*a*). it extends its service to the villages, (*b*). it can stop anywhere to load or unload, (*c*). it can wait for its regular customers, and (*d*). it carries milk right into the heart of the city. Irregularity and uncertainty are its drawbacks, and, therefore, where a railway station is near at hand, the milkman prefers to take his milk by train rather than by motor lorry. With the development of better transport facilities it is expected that milk will be conveyed more quickly and hygienically than at present ; also to obtain lower costs and to lessen competition it is hoped that the different producers will combine on co-operative lines.

Pack-horses (Figs. 2 & 3) with W-shaped wooden panniers in which milk vessels are placed on either side, are gradually going out of use owing to the general improvement in the condition of the roads. *Tum-tums* are more economical, quicker and easier to handle ; a horse between the shafts of a *tum-tum* can haul nearly four times as much as it can carry on its back.

Nearly all the people carrying milk on their heads come from villages within a radius of four miles of the city. Haulage by cycle is a rare feature, practised only by a small newly-started dairy situated 5 miles from the city on the Multan Road.

The transport of milk is important from two standpoints—the sanitary, and the cost involved. The system followed in Lahore is defective both ways. The vessels containing milk are dirty without and dirtier still within. The milkman generally has little idea of the cleanliness which should be an indispensable accompaniment of his trade. He takes pains to clean the outside of the vessel which is open to view, but is indifferent to its inside cleanliness ; the construction of the *valtohis* (Figs. 4 & 5) is such that it does not admit of easy cleansing of the interior. Before pouring in milk they rinse the vessel with water of a kind which many would hesitate to use for their hands. Hence, the *valtohis* provide ' warm, cosy, dark rooms with an abundance of food ' in which

the germs or bacteria can propagate. The handling of milk is equally unsanitary ; as it is being poured from one vessel into another, it is frequently touched with dirty, unwashed hands, and the smaller vessels (*garwis*) with their soiled bottoms are placed on the mouths of the larger ones to act as covers (see Fig. 6). During transport, wisps of straw, not infrequently contaminated with dung, are stuffed into the mouths of the vessels. This permits free admission of dust and dung particles into the milk as it splashes against the straw when the vehicle jolts.

Cost of transport.—All those who bring milk to the city have to arrange for carriage and we have already seen that for transport the *tum-tum* predominates. Some dealers hire a *tum-tum* ; others have their own. From the figures collected on the 5th October, 1930, it is estimated that haulage by *tum-tum* costs Rs. 0/1/6 per maund of milk per mile to those who employ hired vehicles, and Rs. 0/2/3 to those who have their own. Carrying milk on horse-back was found to be more expensive, costing up to Rs. 0/3/3. Those who used lorries paid on an average only Rs. 0/0/7 per maund per mile. The transport expenses of those persons who carried milk on their own heads or used bicycles could not be calculated.

An important reason for the high expense of haulage by *tum-tum* is that the vehicles are seldom loaded to full capacity. The average amount of milk carried on a *tum-tum* was 2 maunds, 30 seers which is at the most one-third of its full load. The charges of the *tum-tum* plying on hire are lower than the cost of transport by privately owned vehicles because in the former case passengers were carried along with the milk. One effect of the prevalent expensive means of transport is that the over-head charges of the milk-importers are unduly high and this burden has ultimately to be borne by the consumers.

Quality of imported milk.—The quality of milk mainly depends upon its physical properties and chemical composition, and its bacterial content. The former has a reference to its general appearance and its value as an article of diet so far as digestible nutrients are concerned, and the latter is of importance from the sanitary standpoint, *i.e.*, whether milk is wholesome and fit for human consumption. The latter is by far the most important, because no matter how rich milk may be in its digestible nutrients, it will remain unfit for human consumption if it contains even a few disease-producing microbes. In the present inquiry the milk imported into Lahore was subjected to both chemical and bacteriological examinations in the Hygiene Laboratory of the Punjab Veterinary College by Mr. P. D. Punj,

I.D.D., and the Hygiene Section staff of the College under the supervision of the Member-in-charge of the inquiry.

From the milk brought into Lahore on the 2nd February, 1930, 86 samples were taken at random and submitted to chemical analysis. The results of these analyses are summarised in the table on the next page. The percentage of adulteration was calculated on the basis of ' solids-not-fat.'

The real extent of adulteration is probably larger than is shown by the figures given in the table because a portion of the adulterated buffalo milk must have been passed off as cow's milk; and the bases for comparison taken were the minimum legal standards, which are much below the average figures.

The contrast between the qualities of cow's and buffalo milk is very significant. Not only is the adulteration in the case of buffalo milk more extensive than in the case of cow's milk, but it is also more intensive, as is shown by the following figures extracted from the table on the next page :—

Adulteration in Cow's and Buffalo Milk.

Kind of milk.	Percentage of samples found adulterated.	Percentage of samples found adulterated with water—		Percentage of samples found skimmed.
		by less than 10 per cent.	by more than 10 per cent.	
Cow's	71·4	42·9	28·5	Nil
Buffalo	84·1	51·2	32·9	9·1

Out of the 14 samples obtained on the morning of 5th October, 1930, and subjected to " Barthel and Orla Jensen's Reductase Test for Grading" with a view to determine the approximate bacterial count per cubic centimeter, 13 or 93 per cent. were found to belong to ' Grade III.', *viz.*, ' Bad milk with bacterial counts ranging from 4,000,000 to 20,000,000 per c. c.,' and only one sample, *i.e.*, about 7 per cent. as belonging to ' Grade II.', *viz.*, ' Milk of fair average quality with 500,000 to 4,000,000 bacteria per c. c.'

This shows that the milk was not only highly adulterated with water, but also full of dangerous bacteria. The former defect will only lower the nourishing qualities of milk, whereas the latter may actually cause disease in the consumer.

Table showing the Results of Chemical Analyses of Samples of Milk Imported into Lahore from the Neighbouring Villages on the 2nd February, 1930.

Kind of milk.	Milk Standards.*		No. of samples examined.	No. of samples found adulterated with water.								No. of samples found both watered *and* skimmed.	Total number of samples found watered *or* skimmed.	Percentage of samples found watered *or* skimmed.
	Percentage of fat.	Percentage of solids-not-fat.		Less than 1 per cent. adulteration.	1 to 5 per cent. adulteration.	5 to 10 per cent. adulteration.	10 to 20 per cent. adulteration.	20 per cent. and more adulteration.	Total No. of adulterated samples.	Percentage to No. of samples examined.	Per cent. range of adulteration with water.			
1. Cow's milk ..	3·5	8·0	21	1	6	2	1	5	*15*	..	0 to 41·8	..	*15*	..
Percentage ..	..	..	..	4·8	28·5	9·5	4·8	23·8	..	71·4		..	..	71·4
2. Buffalo milk ..	5·0	9·0	44	2	10	11	13	1	*37*	..	0 to 32·1	4	*37*	..
Percentage ..	..	..	..	4·5	22·7	25·0	29·6	2·3	..	84·1		..	..	84·1
3. Mixed milk ..	3·5†	8·5†	21	..	3	5	6	..	*14*	..	0 to 14·1	1	*14*	..
Percentage ..	..	..	..	..	14·3	23·8	28·6	..	..	66·7		..	..	66·7

Note.—No sample was found only skimmed.

* Milk Standards, Punjab Adulterations of Foods Act, No. VI. of 1919, as laid down by the Chemical Examiner to the Punjab Government in 1925.

† Figure suggested by Professor Aggarwala for comparative study.

Handu Village.

As pointed out before, Lahore draws its external supply of milk from 65 different villages, and among them Handu is decidedly the most important. This village has an area of 1,181 acres and is situated about a mile to the north of the Grand Trunk Road to Amritsar, some 9 miles from the city. It is a typical milk-producing village, and since the conditions obtaining in the different villages as to milk production and its transportation to the city are similar, a description of conditions prevailing in this village will not be out of place.

According to the census of 1921, the population of the village was 618. There are some 120 families, about half of whom are *Gujars*, both by caste and profession. The village has come to be associated with this caste and in daily talk people refer to it as 'Handu of the *Gujars*.' However, the milk industry is no longer their monopoly and many other communities of the village, *e.g.*, *Arain*, *Mashki*, *Mochi* and *Kashmiri*, have also taken to cattle-keeping as a subsidiary occupation.

According to the last cattle census held in February, 1930, the cattle in the village were counted as follows :—

	Number.
Bulls	91
Cows	161
Calves	59
Buffalo bulls	29
Buffaloes	338
Calves	39
Goats	146
Total ..	*863*

Two points are worthy of note here: first, the popularity of buffaloes as milch animals, and second, the comparatively small number of buffalo calves.

The milk industry entails such a heavy amount of outdoor work—growing of fodder, taking out cattle for grazing, transporting milk to the city—that during the day time one rarely finds an able-bodied man in the village. Even the children go out with herds of cattle and the women take the midday meal out to their menfolk. A vernacular saying depicts this phase of the village life thus :—

ہانڈو گجر۔ رات نوں وسّوں۔ دن نوں اُجڑ

(Handu of the *gujars* is well inhabited during the night, but is a deserted place during the day.)

The village is peculiarly suitable for cattle-keeping and milk production.

It is near Lahore, a centre of great demand. The *kachcha* road connecting the village with the Grand Trunk Road is barely a mile long; thus transport is fairly easy. The soil of the village is very fertile; three or four crops a year being common, green fodder is available for the cattle practically all the year round. Good fodder grasses, like *swank, khabbal, khanni, khawi*, etc., grow freely on the village waste lands and provide excellent grazing. Above all, the land is irrigated by canals, which do not appear to be of recent construction; the people say that even during the Sikh period a canal ran through their lands. Further, there are six large ponds around the village which are never dry; this is a great boon for the buffaloes which are water-loving animals. Lastly, the momentum of an early start is responsible to a certain extent for the almost universal occupation of milk production in this village. The present resident *gujars* of Handu trace their ancestry to a prosperous *gujar*, named Handu, who settled in the village in the seventeenth century and supplied milk to the residents of the town of Baghbanpura near the famous Shalimar gardens.

Nearly the whole of the morning milk is sent to Lahore, the local requirements for milk, curd, *lassi*, etc., being met from the evening yield. There are ten people who transport the milk, each of whom owns a horse and a *tum-tum*. One of them owns a large herd of buffaloes and does his own carting. Another, an *Arora* by caste, is a middleman between the village *gujars* and the city *halwais*. The remaining eight perform the double function of keeping their own milch cattle and also purchasing milk to sell in the city. The other *gujars* of the village and those who have surplus milk, sell it to the middlemen.

'*Middlemen*.'—They buy milk from the villagers at Rs. 8/- and Rs. 9/- per *pacca* maund (50 seers or about 103 lbs.) of cow's and buffalo milk, respectively. Twenty-two *gujars* have taken some advance from the middlemen and supply milk to them at one rupee less than the prevalent rate. The advance represents in most cases the loans of previous years still outstanding. The middlemen are now somewhat reluctant to make fresh advances since the milk trade is not so lucrative as it was two or three years ago, partly due to competition amongst the suppliers and partly to growing unemployment amongst the residents of Lahore.

For the collection of milk the middlemen employ servants who go from house to house both morning and evening and have the animals milked in their presence. The amount collected by a servant depends upon the number of cattle kept by the families which he is to visit. If he merely

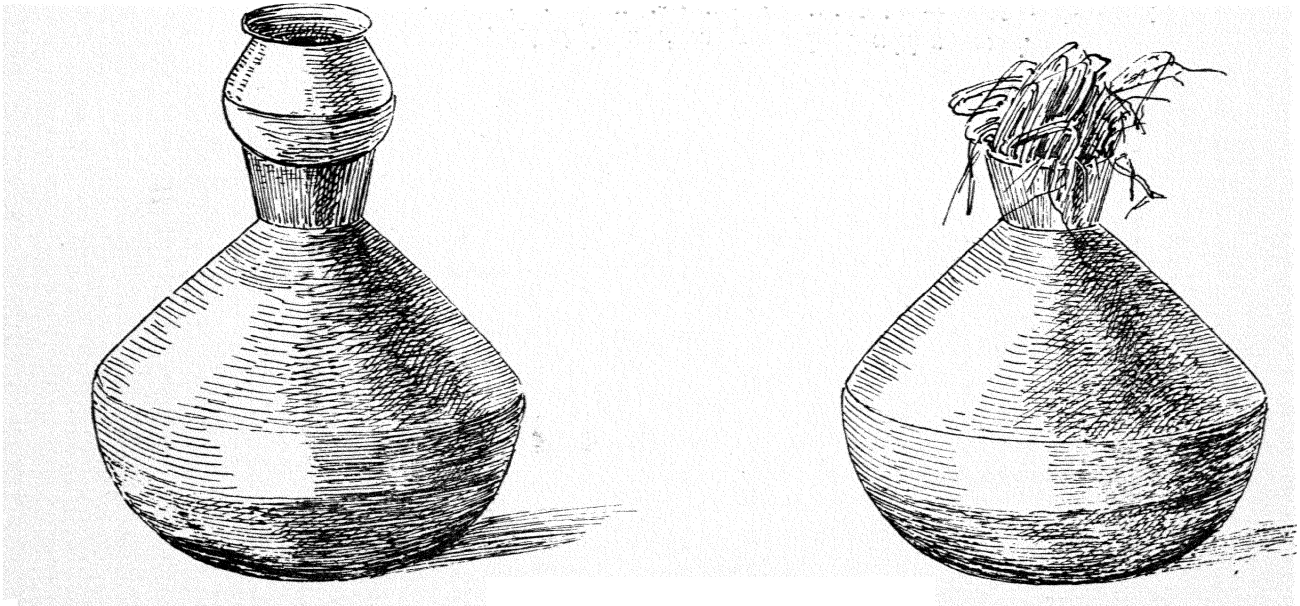


Fig. 4. Brass Valtohis and Garwi.

(The construction of the valtohis does not admit of easy cleansing of the interior ; the garwis with their soiled bottoms are often used as covers for the valtohis and during transport wisps of filthy straw or grass are plugged into the mouths.)

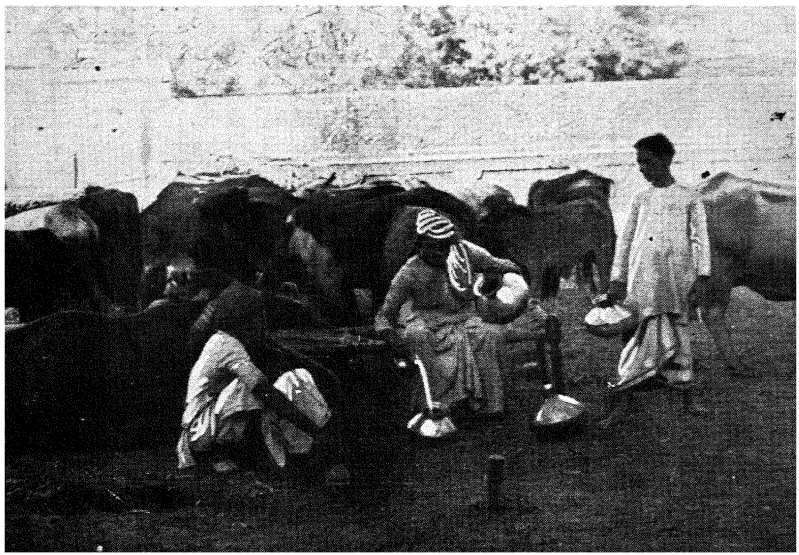


Fig. 5. A Gujar measuring out Milk with a Garwi.

(The handling of milk is equally insanitary ; as it is being poured from one vessel into another, it is frequently touched with dirty unwashed hands.)

brings the milk to the middleman's house he is given Rs. 8/- a month, but if he works whole-time, *i.e.*, helps in the transport of milk and management of cattle, he is paid Rs. 10/- per mensem plus food.

Profits of the 'middleman.'—The middleman as a distinct class has not yet appeared. The income, therefore, of the transporter of milk may be grouped under two heads :—(*a*). his profits as a trader from the purchase of milk in the village and its subsequent sale in the city at a higher rate, and (*b*). his profits as a professional milch cattle keeper.

An estimate of the profits of the 'middlemen.'—The difference between the sale and purchase prices ranges between 8 annas and Re. 1/- per *pacca* maund, or say an average of 12 annas per *pacca* maund. To this may be added the profits arising from the difference in the measures according to which milk is bought and sold. A *pacca* maund consists of 40 *garwis*, the capacity of which is 21 chhataks in the village and 20 in the city. This means an additional profit of 2½ seers or 2 *garwis* of milk per *pacca* maund; or in terms of money Rs. 0/7/6 at the prevailing rate (1930). The gross profit is thus Rs. 1/3/6 per *pacca* maund sold in the city. Against this may be set the expenses of collection and haulage. According to the estimate of the middlemen, 4 annas per *pacca* maund were the expenses of collection and Rs. 1/8/0 per day the cost of maintenance and depreciation of a *tum-tum*—(Rs. 1/4/0 for feeding the horse and Rs. 0/4/0 to cover repairs and depreciation). An average middleman takes about 4 maunds of milk per day to the city. His expenses, therefore, for collection and transport amount to Rs. 2/8/0 for 4 maunds or 10 annas per *pacca* maund. The net profits, therefore, amount to Rs. 2/6/0 per day for 4 maunds or Rs. 0/9/6 per *pacca* maund.

The middleman's actual profits are, however, higher than those shown above. The *gujars* or other cattle keepers perform the milking operation under the vigilant eye of the middleman or his representative, hence their chances of diluting the milk before it reaches the latter are rare. It is really the middleman who starts the process of adulteration, and the seemingly innocuous question asked by the middleman from his wife in the morning while preparing to leave for the city, "Have you 'made' the milk?" conveys the idea of diluting the milk with water.

Further, during the winter season when it gets dark early, the middleman keeps the evening milk collected overnight from his suppliers in wide shallow pans, and the next morning removes the layer of cream that has

come on top. The housewife generally makes *ghi* out of this and so adds to her husband's profits.

Some middlemen on their way to the city get a portion of their milk separated, sell the cream there and then, and mix the separated milk with the remaining milk which they sell as whole milk in the city.

Gujars.—The *gujars* in the Lahore District have not been notified as an agricultural tribe under the Punjab Alienation of Land Act, and, therefore, notified agriculturists cannot sell land to them without the permission of Government. In Handu, however, the *gujars* own the major portion of the arable land which they have inherited from ancestors. Soon after finishing the morning milking they take their cattle out for grazing. During the rainy season grass is plentiful and the cattle are allowed to graze as much as they can, but for the rest of the year fodder crops are cut and fed to the cattle in the fields.

Cost of production.—The main item of expenditure in milk production is the feed given to the cattle. This may be divided into three main groups : (*a*). bulky foods, (*b*). concentrated foods, and (*c*). food adjuncts. The bulky foods include green fodders like grass, maize, *jowar*, wheat, oats, etc., dry fodders such as wheat and rice straw and wheat chaff (*bhusa*), also dried *jowar* stalks. Under concentrates come the various oil-cakes (*khal*), grains, *phhak* (rice husk), *chhillar* (gram husk), bran, etc. Food adjuncts or condiments, though important, are given in very small quantities and most of these do not form part of the daily diet of the animals. They include *loon* (common salt), *gur* (raw sugar), *saunf* (aniseed), *hing* (assafœtida), etc. The concentrated ration allowed to milch cattle in this village remains unchanged for nearly the whole of the year, except that the quantity fed to a buffalo or a cow diminishes as the animal advances in lactation. The most nutritive foodstuffs in this group are ground gram and oil-cakes. *Chhillar* and *phhak* being cheaper than gram are most commonly used. They are light, bulky and fairly palatable foods, and possess laxative properties. The amount of concentrates given to a buffalo yielding 8 to 10 seers of milk a day is :—

	Seers.
Wand (ground gram)	.. 4
Chhillar (gram husk)	.. 4
Phhak (rice husk)	.. 5

At the prevalent market rates (1930) the above ration could be had for 8 annas. A cow yielding 6 to 8 seers of milk is allowed nearly half the ration given to buffaloes. According to the statement of the *gujars* no *phhak* is

given to cattle in the months of *Katak*, *Maghar* and *Poh* (middle of October to middle of January), but in *Baisakh* and *Jeth* (middle of April to middle of June) the allowance is increased to tide over the period of scarce fodder.

The fodder given to cattle follows a definite yearly rotation according to the seasonal crops. This cycle is traced below :—

Magh (the middle of January to the middle of February). During this month *kamad* is the chief fodder; it is given cut and mixed with *senji*, *jawi* and green wheat (*khasil*).

By *Phagan* (the middle of February to the middle of March) *kamad* is finished and *senji* takes its place with *jawi* and green wheat to supplement it.

In *Chet* (the middle of March to the middle of April) *senji* continues to be fed and *maina* (a self-propagating artificial grass), provides a good green fodder.

In *Baisakh* and *Jeth* (the middle of April to the middle of June) scarcity of fodder is experienced, and the animals have to be fed in the stalls on wheat straw. As a result the milk yield falls considerably. Dry cattle are let loose on the stubble of wheat; *haroo makki* (green maize of the month *Har*) is also fed, but only to animals in active lactation.

By *Har* (the middle of June to the middle of July) *moth* commences and coupled with maize relieves the scarcity of green fodders.

During the next three months, *Sawan*, *Bhadon* and *Asoj* (the middle of July to the middle of October) fodder is plentiful; the uncultivated land bears grasses like *swank*, *khabbal*, *khawi*, etc., most of which are very nutritious and palatable when young; the arable land is under *chari*, one of the most important fodder crops in this village.

In *Katak* and *Maghar* (the middle of October to the middle of December) cattle in milk are fed on green maize and dry cattle on *paráli* (rice straw).

By *Poh* (the middle of December to the middle of January) *makki* goes out and recourse is had to mixtures of *kamad* with either *sarson* or *shalgham*.

Most of the *gujars* of Handu own land and nearly half of them own enough to meet their fodder requirements. Others have either to buy fodder or to rent land to grow it. Fodder in the village is not sold by weight but by area. Thus, *chari* could be had this year (1930) at Rs. 8/- per *kanal*, green maize at Rs. 15/-, *kamad* at Rs. 20/-, turnips at Rs. 6/-, *sarson* at Rs. 8/-, *jawi*, green wheat and *senji* at about Rs. 10/-, and *moth* and *maina* at Rs. 9/-.

Fodder is cut and given to the cattle fresh in the fields, hence every cow and buffalo is fed without any consideration of the quantity of milk yielded by her. Roughly speaking, a *kanal* of land under green maize, *senji*, green wheat or *chari* provides a day's fodder for 25 buffaloes or 45 cows; a *kanal* of *kamad* for a slightly larger number and a *kanal* of turnips or *jawi* for about half this number.

A group of experienced *gujars* jointly gave an estimate of the cost of feed for different months of the year of a good buffalo giving at the time of calving nine *garwis* of milk, with the lactation period extending over 14 months, which includes active lactation and dry period from one calving to another. This information is tabulated on the next page. As most of the buffaloes calve in *Asoj* and *Katak*, the estimate was made from this time of the year and each month was taken to be of 30 days' duration.

The total expenses for one such buffalo according to the estimate given will, therefore, be :—

	Rs.	a.	p.
Feeding	378	12	0
Servant charge @ 12 annas per month ..	10	8	0
Sweepers, etc.	1	9	0
Miscellaneous including medicines, special diet at calving and loss from occasional stoppages of milk yield	30	0	0
Total ..	*420*	*13*	*0*

On this basis the sale of milk will bring the *gujar* Rs. 526/8/0 per buffalo during a period of 14 months, and this will give him a net profit of Rs. 105/11/0. Thus he may expect an average profit of about Rs. 7/8/0 per month per good buffalo, with a cost of production of Rs. 7/3/0 per *pacca* maund. This amount of Rs. 7/8/0 per month per buffalo does not represent the real net profit of the *gujar*, since it includes the remuneration for the work put in by him and his family and the interest on the capital invested. The depreciation in his stock is compensated for in a great measure by the young stock reared each year.

The cows calve generally in *Phagan* and *Chet* (the middle of February to the middle of April). Their lactation period usually extends over 13 months. They are given practically the same kind of food as buffaloes, but in smaller quantities. As a *gujar* put it, "a cow eats half as much as a buffalo and gives two-thirds the milk yield." It has been estimated that it costs Rs. 5/- to Rs. 5/8/0 to the *gujar* to produce one maund (*pacca*) of cow's milk.

Estimated Cost of Feeding a Good Buffalo and the Value of the Milk Yielded by her in One Lactation.

Month.	Feed.	Cost.	Daily cost of feed.	Monthly cost of feed.	Daily milk yield.	Value of milk yielded in the month.*	Remarks.
		Rs. a. p.	Rs. a.	Rs. a.	Srs. Chs.	Rs. a.	
1. *Asoj* .. (Sep.-Oct.)	*Chari* ..	0 10 0					
	Concentrates	0 10 0	1 4	37 8	11 13	60 12	Buffalo calves
2. *Katak* .. (Oct.-Nov.)	Green maize ..	0 10 0					
	Concentrates	0 8 0	1 2	33 12	11 13	60 12	
3. *Maghar* .. (Nov.-Dec.)	*Kamad* ..	0 5 6					
	Turnips or *sarson* ..	0 5 6					
	Concentrates	0 8 0	1 3	35 10	11 13	60 12	The buffalo is covered now.
4. *Poh* .. (Dec.-Jan.)	Ditto ..	Do.	1 3	35 10	11 13	60 12	
5. *Magh* .. (Jan.-Feb.)	*Kamad* ..	0 4 0					
	Jawi or green wheat ..	0 8 0					
	Concentrates	0 8 0	1 4	37 8	11 13	60 12	
6. *Phagan* .. (Feb.-Mar.)	*Senji* ..	0 8 0					
	Concentrates	0 8 0	1 0	30 0	10 8	54 0	
7. *Chet* .. (Mar.-Apr.)	*Senji* or *maina*	0 8 0					
	Concentrates	0 8 0	1 0	30 0	10 8	54 0	
8. *Baisakh* .. (Apr.-May)	Stubbles	Free					
	Straw ..	0 3 0					
	Concentrates	0 10 0	0 13	24 6	7 14	40 8	
9. *Jeth* .. (May-June)	Ditto ..	Do.	0 13	24 6	6 9	33 12	
10. *Har* .. (June-July)	*Moth* or maize	0 8 0					
	Concentrates	0 6 0	0 14	26 4	5 4	27 0	As the milk yield diminishes less concentrates are given.
11. *Sawan* .. (July-Aug.)	Grass	Free					
	Chari ..	0 4 0					
	Concentrates	0 4 0	0 8	15 0	2 10	13 8	
12. *Bhadon* .. (Aug.-Sep.)	Grass	Free					
	Chari ..	0 2 0					
	Concentrates	0 4 0	0 6	11 4	..	..	
13. *Asoj* .. (Sep.-Oct.)	*Chari* ..	0 6 0					
	Concentrates	0 2 0	0 8	15 0	..	..	
14. *Katak* .. (Oct.-Nov.)	*Chari* or maize	0 6 0					
	Concentrates	0 6 0	0 12	22 8	..	..	
Total for the lactation ..		..	..	*378 12*	*3,071 4*	*526 8*	

* Calculated at Rs. 9/- per *pacca* maund (50 seers).

Note.—The estimates are based on information supplied by the *gujars* of Handu.

These estimates have been prepared for the period when 'all goes well,' which condition often does not prevail. Theft of good cattle is not a rare occurrence ; outbreaks of contagious diseases are fairly common, which, while proving fatal to some animals, considerably decrease the milk yield of others so affected. No arrangements exist in the village for veterinary aid, and the nearest hospital is at the Lahore Veterinary College, nine miles away.

The standard of living of the *gujars* and other milk producers in the village is low ; illiteracy and indebtedness prevail ; the cattle are ill-fed and housed under insanitary conditions. These factors combine to show that the people in Handu village are not doing very well, and unless a strong and sustained effort is made to organise conditions of stock-breeding, and the collection, storage and transport of milk on modern co-operative lines, there is little hope of improvement in the position or living of the milk producers, or of their cattle, or in obtaining a cleaner and safer supply of milk for the city of Lahore.

II. The Internal Sources of Milk Supply.

According to a cattle census made in Lahore in January, 1930, the total number of milch cattle was found to be 13,338, of which 3,798 were cows and 1,813 buffaloes, capable of giving milk. These were distributed among the following sets of owners :—

(*a*). *Professional milch cattle keepers, e.g., gujars and gowalas.*—They owned 4,293 animals or 76 per cent. of the total number of milch cattle. Of these, 3,119 (73 per cent.) were cows and 1,174 (27 per cent.) buffaloes. A house to house inquiry conducted among the *gujars* showed that their animals yielded 423 maunds, 30 seers of milk per day.

(*b*). *Dairies.*—Out of the 15 dairies inside Lahore, only 4 kept their own cattle, numbering 178 cows and 70 buffaloes or about 5 per cent. of the total. The Lahore Cantonment Military Dairy Farm was not included as it is outside the Lahore Municipal limits. The daily milk yield of the dairy cattle was about 29 maunds, 25 seers. Eleven out of the 15 dairies were not dairies in the real sense of the term as their proprietors were only agents or middlemen, purchasing milk from milkmen living both inside and outside the city at fixed prices and selling it, probably in many

cases after dilution or part separation of fat, to their customers at higher rates.

(*c*). *Gowshalas* or charitable institutions for maintaining old and decrepit cattle. There is only one such place in Lahore and it had 53 cows capable of yielding milk, giving in all about 2 maunds, 35 seers of milk a day.

(*d*). *Persons who keep milch cattle to supplement income.*—These persons need not necessarily belong to the poorer classes, although most of them do.

(*e*). *Private owners, i.e.,* those who keep their own animals to meet domestic requirements. This and the previous class overlap since many persons of this class also sell the milk left, over and above their own requirements.

The classes (*d*). and (*e*). owned 1,017 animals or 18 per cent. of the total. Of these, 448 (45 per cent.) were cows and 569 (55 per cent.) buffaloes. Compared with the number of cattle owned, the persons belonging to (*d*). and (*e*). classes were far more numerous than those in class (*a*). Therefore, the house to house method of investigation was abandoned in their case and to arrive at a general estimate the following data was collected regarding the daily milk yield of their cattle :—

The Daily Milk Yield of Cattle Owned by Classes (d) and (e).

Animal.	No. of cattle examined.	No. in milk.	Total yield of milk per day.	Average daily milk yield per animal.
			Srs. Ch.	Srs. Ch.
Cows	55	45	234 12	4 4
Buffaloes	26	22	157 4	6 1

From the data given above, 4 seers per cow and 6 seers per buffalo may be taken as a fairly accurate estimate of their average daily milk yields.*

*Mr. Shiva Datta on page 7 of his report "The Milk Supply of Lahore in 1921," takes 2 seers and 3 seers as the average milk yield per cow and buffalo. Howsoever deplorable the condition of our cattle may be, it is doubted if these figures are correct. The methods followed by him in arriving at these figures are not given, but only five years previous to his undertaking his investigation, in a similar inquiry conducted at Lahore by Bhai Kartar Singh, the average daily milk yield per cow and buffalo in private 'sheds' was estimated at 8 lbs. and 14 lbs., respectively (see his "Notes on Dairying"). The only explanation Mr. Shiva Datta has given on the point is in a foot-note, which says, "The average yield of cows and buffaloes have been determined with proper regard to the number of dry animals (of which there were a good many) in the total number" (p. 7); a very general statement.

Accordingly the total amount of milk yielded by the cattle owned by the classes (*d*). and (*e*). comes to 130 maunds, 6 seers a day.

There is a higher percentage of dry animals among the herds of the professional milch cattle keepers than among the animals owned privately, as the following table shows. So much divergence in the percentage of dry cattle is due firstly to the conception of the phrase 'dry cattle' held by the two classes. If a privately owned cow gives one seer of milk a day it is said to be 'still in milk,' whereas a *gujar* would consider it a dry animal. Secondly, private owners seldom keep dry stock, which they either sell off or send to some neighbouring village until the next calving on what is known as '*adhiara system.*'

Percentage of Dry Animals kept by Professional and Private Owners.

	Total No. of cattle.	Dry Cattle.	
		Number.	Percentage.
Professional milch cattle keepers ..	4,293	1,564	36
Private owners	81	15	17

According to a contemporary inquiry conducted at Lyallpur, 30 per cent. of cows and 44 per cent. of buffaloes belonging to the *gujars* were dry. The corresponding figures for privately owned cattle were 22 and 13 per cent.*

Goats kept for milk.—The number of goats in the city, kept exclusively for milk, was counted as 552. Although less important in comparison with cows and buffaloes, they cannot be left out in a survey of the milk supply. Most of these animals are owned by professional men in herds of from fifteen to forty each, and were estimated to be giving in all about 7 maunds, 14 seers of milk per day.

* "Report on a Preliminary Survey of the Milk Supply of Lyallpur in 1927" by Labh Singh, page 5. (Board of Economic Inquiry, Punjab, Rural Section Publication No. 22).

Total Milk Supply of Lahore.

To summarise, the present milk supply of Lahore is estimated to be as follows :—

	Mds.	*Srs.*
(1). Imports from outside	613	9
(2). Internal Production—		
(*a*). Professional milk producers owning 2,678 cows and 1,095 buffaloes	423	30
(*b*). Dairies (178 cows and 70 buffaloes) ..	29	25
(*c*). Gowshala (53 cows)	2	35
(*d*).-(*e*). Milk from privately owned cows and buffaloes; (448 cows at 4 seers per cow, and 569 buffaloes at 6 seers per buffalo)	130	6
Goats, 552	7	14
Total ..	*1,206*	*39*

A comparison of the above figures with those obtained in the two previous inquiries held in 1916 and 1921 is given below :—

Table showing the Daily Milk Supply of Lahore in Different Years.

Year.	Milk produced internally.	Milk imported.	Total supply.
	Seers.	Seers.	Seers.
1916	14,935	14,789	*29,324*
1921	12,637	14,000	*26,367*
1930	23,750	24,529	*48,279*

As stated before, there appears to be an error in the figures for 1921. Imports show a decrease of 789 seers as compared with the figures for 1916. The amount of milk produced internally is shown to have diminished by 2,302 seers, in spite of the fact that the number of milch cattle within the Lahore Municipal area increased by 31 per cent. during the period between 1916 and 1921.

Between 1921 and 1930 the number of milch cattle increased still further by 33 per cent. If compared with the number of cattle in 1916

the increase is 75 per cent. The actual figures are :—

Year.	*Number of milch cattle.*
1916	4,160
1921	5,453
1930	7,278

Thus it is clear that there has been a steady increase in the daily milk supply of the city of Lahore, probably proportionate to the increase in population. The relative amounts derived from within the Municipal area and imported from without have remained about the same. With regard to the internal sources of supply there appears to be a steady increase in the amount supplied by the professionals as against that derived from private owners. The following table shows the percentage contribution of the various sources of supply :—

Percentage Contribution of the Various Sources of the Milk Supply.

Year.	Percentage to total supply.			
	Professional producers.	Amateur producers.	Imports.	Total.
1916 ..	33·7	15·8	50·5	100·0
1921 ..	34·2	13·2	52·6	100·0
1930 ..	38·4	10·8	50·8	100·0

Quality of milk sold inside the city.—In all 414 samples of milk sold in the city were chemically analysed. Of these, 60 samples were taken from the milk sold by *gujars* and the remaining 354 of milk put up by the *halwais* for sale. The results of these analyses are given in the table on the next page on lines similar to the table on page 20.

This table shows that about two-thirds (62·5 per cent.) of the milk reaches the consumers in an adulterated condition. The most common method of adulteration is to add water. Thus, out of the 414 samples analysed, the number of those containing up to 10 per cent. of extraneous water was found to be 129 (31 per cent. of the total), those with 10 to 20 per cent. water, 56 (14 per cent.) and in 19 samples (5 per cent.) adulteration with water rose above 20 per cent. The maximum amount of adulteration recorded is 56·5 per cent., *i.e.*, to one seer of pure milk 1 seer and 2 chhataks of water was added. Fifty-five samples or 13 per cent. of the total suffered from extraction of fat by skimming.

Table showing the Results of Chemical Analyses of 414 Samples of Milk Sold in the City of Lahore.

Kind of milk.	Milk Standards.*		No. of samples examined.			No. of samples found adulterated with water alone.								Samples found skimmed only.		No. of samples found both watered *and* skimmed.	Total No. of samples found watered *or* skimmed.	Percentage of samples found watered *or* skimmed.
	Percentage of fat.	Percentage of solids-not-fat.	Fresh milk.	Heated milk.	Total.	Less than 1 per cent. adulteration.	1 to 5 per cent. adulteration.	5 to 10 per cent. adulteration.	10 to 20 per cent. adulteration.	20 per cent. and more adulteration.	Total No. of adulterated samples.	Percentage to No. of samples examined.	Per cent. range of adulteration with water.	No.	Percentage.			
Cow's milk ..	3·5	8·0	119	47	*167*	14	22	14	13	6	*69*	..	0·1 to 43·1	22	..	2	*91*	..
Percentage ..	..	..	..	..	..	8·4	13·2	8·4	7·8	3·5	..	41·3		..	13·1	..	..	54·4
Buffalo milk ..	5·0	9·0	97	110	*207*	3	25	42	38	13	*121*	..	0·5 to 56·5	25	..	12	*146*	..
Percentage ..	..	..	..	..	..	1·4	12·1	20·3	18·3	6·3	..	58·4		..	12·0	..	..	70·4
Mixed milk ..	3·5†	8·5†	6	34	*40*	2	2	5	5	..	*14*	..	0·2 to 17·0	8	..	..	*22*	..
Percentage ..	..	..	..	..	..	5·0	5·0	12·5	12·5	..	..	35·0		..	20·0	..	..	55·0

* **Milk Standards, Punjab Adulterations of Foods Act, No. VI. of 1919, as laid down by the Chemical Examiner to the Punjab Government in 1925.**
† **Figure suggested by Professor Aggarwala for comparative study.**

The milk supplied by *gujars* to consumers is in no way purer than that obtained from the *halwais*. Out of 60 samples of milk taken direct from the *gujars*, only 23 came up to standard; the remaining 37 were found faulty: 32 by addition of water and 5 by abstraction of the fat. In 22 samples extraneous water was 10 per cent. or less, in 6 cases 10 to 20 per cent. and in 4 above 20 per cent. It was noted in connection with the imported milk that buffalo milk was more highly adulterated than cow's milk. This is confirmed by the chemical analyses of milk sold in the bazar, the results of which are given in the table on the last page; and from which the following figures have been abstracted.

Adulteration in Cow's and Buffalo Milk Sold in the Bazar.

Kind of milk.	Percentage of samples found adulterated or skimmed.	Percentage of samples found adulterated with water—		Percentage of samples found skimmed.
		by less than 10 per cent.	by more than 10 per cent.	
Cow's	54·4	30·0	11·3	13·1
Buffalo	70·4	33·8	24·6	12·0

FACTORS AFFECTING THE SUPPLY OF MILK.

The supply of milk depends upon two main factors, (*a*). number of animals in milk, and (*b*). sufficiency of green fodder.

(*a*). *Calving seasons of cows and buffaloes.*—In normal health cows and buffaloes come in heat every third or fourth week, the period of œstrum lasting from two to four days. This being so, under conditions of promiscuous breeding one would expect the number of calvings in each month to remain more or less uniform all the year round. Such, however, is not the case, because most of the cattle-keepers are particular to get their cows or buffaloes covered in certain seasons. Those who are familiar with their routine know that the cows show a higher percentage of calvings in January, February and March than during the remaining months of the year. During autumn cows calve the least. On the other hand, the season when most of the buffaloes calve is autumn.

The table on the next page shows the percentage distribution of calvings in different months of the year by cows and buffaloes in certain dairying centres. The figures for the Military Dairies, Northern Circle, were compiled from the monthly statements submitted by 19 dairies to

the Assistant Controller of Military Dairy Farms, Northern Circle, and relate to the year 1st April, 1930, to 31st March, 1931. Since the table does not take into account the variations in the number of cattle every month, figures are also given for the Northern Circle dairies showing monthly calvings per hundred cows and buffaloes.

From this it will be observed that the number of cows in milk is at its maximum during the three months, January to March; the corresponding period in the case of buffaloes is August to October. Roughly speaking the cows are more useful as milch animals during the first half of the year and buffaloes during the latter half. With respect to the cows there is a popular saying among the *gujars*:

گائیں تے سلاریاں - چڑھدے کتک ماریاں

"The (milk of the) cows and (the colour of) the *salaries*—the gorgeously coloured turbans commonly used by the *gujars*—fade away with the advent of *Katak* (middle of September)."

We have seen that although the average milk yield of a cow is less than that of a buffalo, yet inside the city the number of cows is twice that of buffaloes. Cow's milk, therefore, forms an important portion of the internal production of the town, but of the milk imported, buffalo milk forms the larger portion.

The table on page 38 shows the percentage of cows and buffaloes in milk during the different fortnights in 1929 and 1930, at the Lahore Cantonment Military Dairy Farm. Graph 1. prepared from this table shows graphically how cows and buffaloes relieve each other's scarcity of milk: when the percentage of cows in milk falls, the percentage of buffaloes in milk goes up and *vice versa*.

(*b*). *Sufficiency of fodder.*—Other things being equal, the yield of milk varies with the sufficiency or otherwise of fodder. It is a common experience to find a considerable number of animals falling off in their milk yield when the supply of green fodder is scarce or exhausted. There are two periods of scarcity of fodder in the Lahore district: (1). December and January, and (2). April and May. In the latter period scarcity is more severe and is tided over by keeping the animals on wheat chaff (*bhusa*) and increasing the quantity of concentrated foods. During the rainy season the supply of green and succulent fodder is abundant and the milk yield rises.

Table showing Percentage of Calvings during the Different Months of the Year.

Locality.	Kind of animal.	Number of calvings.	Percentage of calvings spread over different months.											
			January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
* College Dairy, Poona ..	Buffaloes ..	428	6·7	5·2	3·0	2·0	1·4	6·3	13·5	11·4	15·0	20·0	9·0	6·5
* Poona Military Dairy..	Do.	851	6·7	7·3	4·2	4·3	5·0	5·4	10·3	13·3	14·4	11·3	10·3	7·0
† Agricultural College Dairy, Lyallpur. ..	Cows	50	11	9	11	10	10	8	11	7	4	6	4	9
‡ Military Dairies, Nothern Circle, (Punjab, North-West Frontier and Baluchistan)	Do.	956	15·2 (*12·3*)	14·9 (*12·0*)	14·7 (*12·0*)	10·1 (*8·1*)	6·2 (*6·4*)	6·1 (*4·8*)	5·2 (*4·0*)	5·1 (*4·7*)	3·3 (*2·5*)	4·9 (*4·0*)	5·0 (*3·9*)	9·3 (*7·4*)
	Buffaloes	935	5·3 (*4·4*)	4·0 (*3·4*)	3·1 (*2·6*)	3·2 (*2·8*)	2·8 (*3·3*)	5·2 (*4·1*)	11·4 (*9·6*)	14·8 (*13·6*)	19·5 (*15·8*)	16·4 (*13·6*)	8·6 (*7·2*)	5·6 (*4·6*)

* ' Notes on Dairying,' by Bhai Kartar Singh, page 3.

† ' The Lyallpur Agricultural College Dairy Herd, 1914-29,' by D. P. Johnston and S. Kartar Singh (Journal of the Central Bureau of Animal Husbandry and Dairying in India, January 1930, Volume III., Part IV.). The figures represent the average for 14 years.

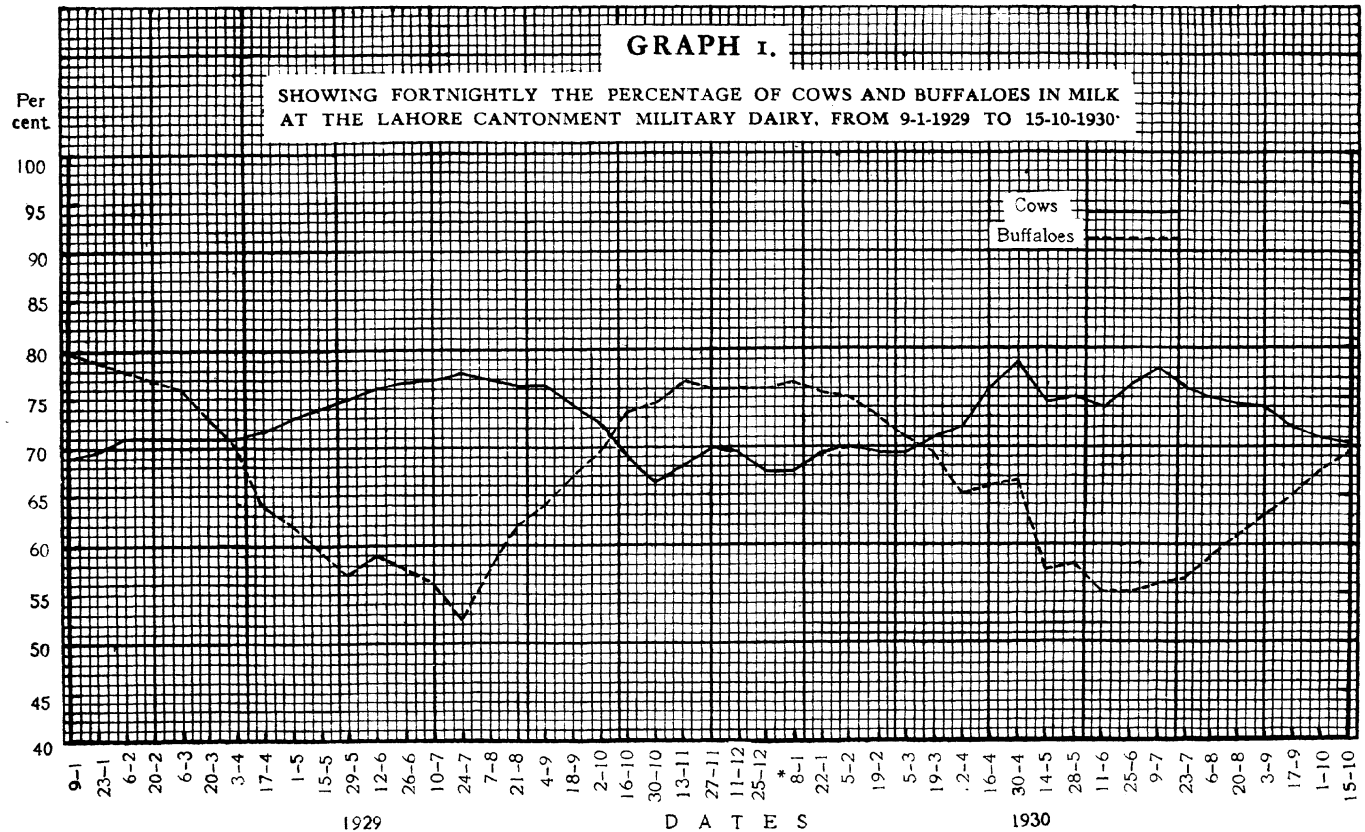
‡ The figures were compiled from the records in the Office of Assistant Controller of Military Dairy Farms, Northern Circle. Figures in brackets are adjusted figures showing monthly calvings per hundred cows and buffaloes, respectively.

The resultant effect of these two factors—calving seasons of the milch cattle and sufficiency or otherwise of green fodder—is, that the supply of milk is sufficient during January, February and March, but dwindles during April, May, June and July, increases a little during August and September and is again sufficient during October, November and December.

Table showing Fortnightly the Percentage of Cows and Buffaloes in Milk in the Military Dairy Farm, Lahore Cantonment, in 1929 and 1930.

1929			1930		
Fortnights.	Percentage of cows in milk.	Percentage of buffaloes in milk.	Fortnights.	Percentage of cows in milk.	Percentage of buffaloes in milk.
9-1-29	69·0	80·0	8-1-30	67·5	76·5
23-1-29	69·5	79·0	22-1-30	69·5	75·5
6-2-29	71·0	78·0	5-2-30	70·0	75·0
20-2-29	71·0	77·0	19-2-30	69·5	73·0
6-3-29	71·0	76·0	5-3-30	69·5	71·0
20-3-29	71·0	73·0	19-3-30	71·0	69·5
3-4-29	71·0	70·0	2-4-30	72·0	65·0
17-4-29	71·5	64·0	16-4-30	76·0	66·0
1-5-29	73·0	62·0	30-4-30	78·5	66·5
15-5-29	74·0	59·5	14-5-30	74·5	57·5
29-5-29	75·0	57·0	28-5-30	75·0	58·0
12-6-29	76·0	59·0	11-6-30	74·0	55·0
26-6-29	76·5	57·5	25-6-30	76·5	55·0
10-7-29	77·0	56·0	9-7-30	78·0	56·0
24-7-29	77·5	52·5	23-7-30	76·0	56·5
7-8-29	77·0	57·5	6-8-30	75·0	59·0
21-8-29	76·5	62·0	20-8-30	74·5	61·0
4-9-29	76·5	64·0	3-9-30	74·0	63·0
18-9-29	74·5	67·0	17-9-30	72·0	65·0
2-10-29	72·5	69·5	1-10-30	71·0	67·5
16-10-29	69·0	73·5	15-10-30	70·5	69·5
30-10-29	66·5	74·5	29-10-30	69·5	72·0
13-11-29	68·0	76·5	12-11-30	68·0	72·5
27-11-29	70·0	76·0	26-11-30	66·5	72·0
11-12-29	69·5	76·0	10-12-30	66·0	73·0
25-12-29	67·5	76·0	24-12-30	65·5	74·0

Note.—These figures were compiled from the records in the Office of Assistant Controller of Military Dairy Farms, Northern Circle.


GRAPH 1.
SHOWING FORTNIGHTLY THE PERCENTAGE OF COWS AND BUFFALOES IN MILK AT THE LAHORE CANTONMENT MILITARY DAIRY, FROM 9-1-1929 TO 15-10-1930.
Per cent.
100
95
90
85
80
75
70
65
60
55
50
45
40
Cows
Buffaloes
9-1
23-1
6-2
20-2
6-3
20-3
3-4
17-4
1-5
15-5
29-5
12-6
26-6
10-7
24-7
7-8
21-8
4-9
18-9
2-10
16-10
30-10
13-11
27-11
11-12
25-12
*
8-1
22-1
5-2
19-2
5-3
19-3
2-4
16-4
30-4
14-5
28-5
11-6
25-6
9-7
23-7
6-8
20-8
3-9
17-9
1-10
15-10
1929
D A T E S
1930

CHAPTER III.

DEMAND FOR MILK IN LAHORE.

'Production' and 'consumption' are inter-related economic phenomena, and having studied the one, we now pass on to the other. We have seen that Lahore consumes about 1,207 maunds of milk every day. More than half of this is consumed as milk and the rest is converted into curd and sweetmeats. About 500 maunds of milk is distributed through the *halwais*, the following being an analysis of their sales :—

		Maunds.
Fresh milk	..	90
Heated ,,	..	210
Curd	..	150
Khoya and sweets	..	50
Total	..	*500*

At the time of publication of this report the census figure for Lahore became available, and as the census was taken only some five months after the figures of the milk supply were gathered, its figure may be taken in preference to any other estimate in calculating the *per capita* consumption of milk. The population of the Lahore Municipal area on 27th February, 1931, stood at 400,075, which gives 1·93 chhataks or 0·247 lbs. of milk per head per day.

The tables on the next page go to show that Lahore compares favourably in demand for milk with other Indian cities, though the figures hardly confirm the accepted idea of the Punjabi's dependence on milk. In comparison with Western countries, however, the consumption in Lahore is very low.

Consumption of Milk According to Income Groups.

We may now pass on to study how the total supply of milk is distributed among the various grades of society in Lahore. Here, as elsewhere, many of the poor people and their children go without milk almost entirely ; they look upon it as a luxury to be had only occasionally, or as a medicine to be administered to the sick ; whereas, the well-to-do families who keep milch cattle of their own have an abundance of it, the amount consumed in some cases exceeding one seer per day for each member of the family. The amount consumed varies widely with the income earned.

The study of the extent and rate of the variation in consumption necessitated the collection of data from a large number of families

Daily Per Capita Milk Consumption in some Indian Cities.

Name of the city.	Year.	Milk consumption per head per day.
		lbs.
1. *Lahore*	*1930*	*0·25*
	1921*	0·21
	1916†	0·29
2. Lyallpur	1927‡	0·54
3. Bombay	1925§	0·19
	1921*	0·16
	1913‖	0·27
4. Calcutta	1913‖	0·26
5. Madras	1928¶	0·25 (Measure)
6. Delhi	1930¶	0·25
	1913‖	0·23
7. Ahmadabad	1913‖	0·24
8. Poona	1913‖	0·22
9. Srinagar	1930¶	0·31

* 'Milk Supply of Lahore in 1921,' by Shiva Datta, p. 28.
† 'Notes on Dairying,' by Bh. Kartar Singh, p. 2.
‡ 'A Preliminary Survey of the Milk Supply of Lyallpur,' by Labh Singh, p. 7.
§ 'City Milk Supply, its Improvement,' by Zal R. Kothavala (in Journal of Animal Husbandry for 1929).
‖ 'Milk Problem in Indian Cities,' by Dr. L. L. Joshi, p. 30.
¶ Figures obtained from the local municipal bodies.

Annual Per Capita Consumption of Milk in Various Foreign Towns and Countries for Different Years.

Town.*	Consumption in *gallons.*	Country.†	Consumption in *gallons.*
New York (1928-29) ..	45·50	Switzerland (1922) ..	67·0
Hamburg („) ..	36·40	U. S. A. (1926) ..	55·3
		„ (1924) ..	54·8
Copenhagen („) ..	36·40	„ (1922) ..	50·0
		„ (1917) ..	42·4
Chicago („) ..	22·75	Canada (1922) ..	27·3
		Great Britan (1924) ..	18·7‡
Glasgow („) ..	18·20	„ (1922) ..	30·9
		United Kingdom (1914) ..	22·2
Berlin („) ..	18·20		
		France (1922) ..	21·5
London („) ..	16·78	New South Wales (1931) ..	20·0§
Paris („) ..	15·0	Spain (1925) ..	13·8
Lahore (*1930*) ..	*9·03*	Italy (1913) .	4·2

* 'Milk Price Margins,' Empire Marketing Board publication No. 51, p. 57.
† From Statistical Bulletin No. 25, U.S.A., Department of Agriculture (1929).
‡ This seems to be a misprint in the Statistical Bulletin.
§ N. S. W. Official Year Book, 1930-31, p. 551.

with very varied incomes. A questionnaire was drawn up (see Appendix D.) and was filled in by what is known as the 'interview method.' The alternate method of sending forms to different families for filling in the actual amount of milk purchased during a specified period is not suitable to this country where a large majority of the population is illiterate and the general public has not yet begun to appreciate the value of scientific inquiries.

In all, 984 forms were filled in. Of these, 32 were rejected mostly because they either omitted to show the income or the size of the households. The remaining 952 forms represented the following professions :—

1.	"Intelligentsia"—		
	Lawyers ..	33	
	Doctors ..	29	
	Officials and College lecturers ..	68	130
2.	Clerks	..	203
3.	Businessmen	..	87
4.	Students	..	141
5.	Artisans—		
	Blacksmiths ..	20	
	Carpenters ..	16	
	Mechanics ..	12	
	Pressmen ..	31	
	Masons ..	31	
	Tailors ..	23	
	Shoemakers ..	17	150
6.	Skilled labourers—		
	Barbers ..	21	
	Tonga drivers ..	26	
	Washermen ..	19	
	Water-carriers ..	11	77
7.	Unskilled labourers—		
	Coolies, porters, *chaukidars* and peons ..	102	
	Sweepers	19	
			121
8.	Miscellaneous	..	43
	Total ..		***952***

It is not claimed that the list is exhaustive; nor, that the number of cases taken from each profession is in proportion to its numerical importance in the city. The main point is that no important section of the population was totally ignored, and the basis on which the inquiry was based was broad enough to give representative figures.

As regards religious faiths, out of 952 households, 543 were Hindu, 308 Mohammedan, 45 Sikh, 47 Christian and 18 others. Out of 47 Christian households, 25 were European and the remaining 22 Indian.

A real difficulty was experienced in recording the income of the families. Unaccustomed to economic surveys such as the present one, those people who came within the range of the Income-Tax Department hesitated to give their exact income. This difficulty was overcome by omitting their names and by demarcating broad 'income groups' and simply asking them to indicate the groups to which they belonged.

The following table shows the various 'income groups' adopted and the number of households studied, along with the size of the average household for each income group.

Table Classifying Families Examined according to Income Groups.

Group.	Definition of the income group (Income per mensem in Rupees).	No. of families.	Average No. of persons per Family.		
			Above 14 years.	Below 14 years.	Total.
A. ..	Up to 25	185	1·5	0·6	2·1
B. ..	26 to 50	291	1·3	0·3	1·6
C. ..	51 to 100	216	2·3	0·9	3·2
D. ..	101 to 200	93	3·3	2·1	5·4
E. ..	201 to 500	80	3·9	2·6	6·5
F. ..	501 to 1,000	44	3·5	2·2	5·7
G. ..	1,001 to 1,500	19	3·7	2·9	6·6
H. ..	1,501 to 2,000	8	3·8	3·0	6·4
I. ..	2,001 and more	16	4·9	1·5	6·4
	All Incomes ..	*952*	*2·2*	*1·2*	*3·4*

Income Groups A., B. and C. taken together form the major portion of the Lahore population. Group A. consists mainly of sweepers, peons, gardeners, low class artisans and unskilled labourers, and to Groups B. and C. belong most of the artisans, merchants and clerks. The higher income groups cannot be associated with any particular class.

The average number of persons per household, on the basis of the 952 cases examined is 3·4; 2·2 of these are of ages 14 years and above and 1·2 below 14 years. The number of people in a household as

shown in the foregoing table, seems unduly low for the Income Groups A., B. and C., chiefly because of the presence in them of a large number of persons who live alone in the city, leaving their families behind in villages. Group B. is all the more influenced because it includes 87 college students residing in hostels. Thus, if the first three income groups be ignored, the average number of persons rises to 5·9 per household.

In Group A., out of 185 households 54 reported that milk did not form a part of their food. The writer has come across a good number of such families which cannot afford to provide milk for their children even when they are ill; it is not used regularly by the adults in such families while in good health. Only 60 households bought milk daily and then mostly for their children, and the remaining 70 took milk occasionally, say not more than twice a week.

Conditions improve when we come to the next group. Out of 291 households in the Group B., 22 may be called non-consumers, 53 casual consumers and 216 daily or regular consumers. In Group C. only 4 households were non-consumers, another 8 casual consumers while the remaining 204 households took milk daily. With one solitary example in Group E., all households with an income of more than Rs. 100/- per mensem consumed milk regularly.

The following table shows the average amount of milk consumed daily by persons in the different income groups:—

Average Daily Consumption of Milk in the Different Income Groups.

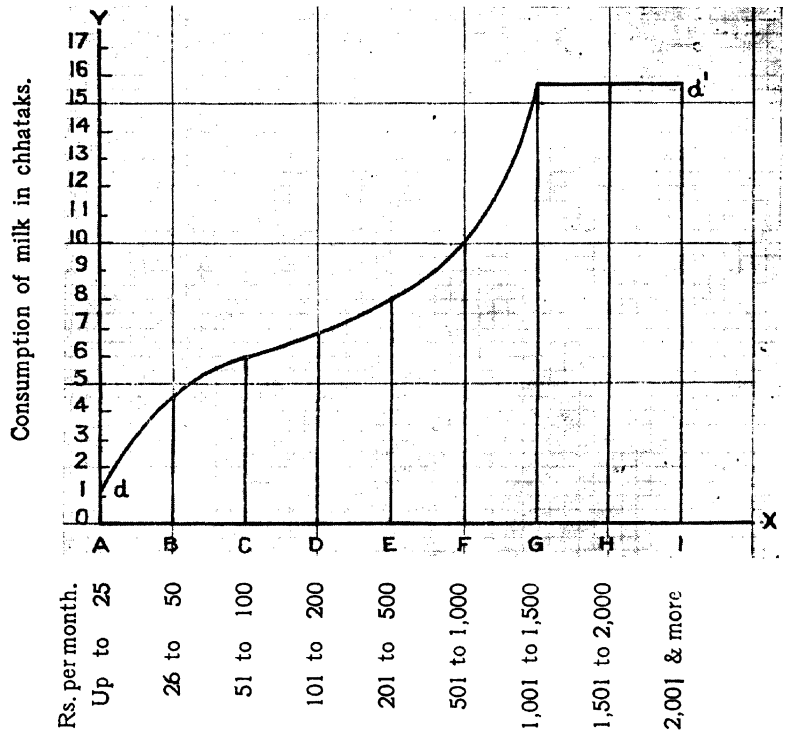
Group.	Income Groups (Per mensem in Rupees).	No. of persons.	Percentage of consumers and non-consumers.			Daily consumption per head in—		
			Non-consumers.	Casual.	Regular.	Chh.	Tola.	Ozs.
A. ..	Up to 25	384	29	38	33	1	2*	2·8
B. ..	26 to 50	549	10	33	57	4	3*	9·2
C. ..	51 to 100	686	3	3	94	6	0*	12·0
D. ..	101 to 200	503	..	..	100	6	4	13·6
E. ..	201 to 500	521	..	..	100	8	0	16·0
F. ..	501 to 1,000	251	..	..	100	10	0	20·0
G. ..	1,001 to 1,500	126	..	..	100	15	3	31·2
H. ..	1,501 to 2,000	51	..	..	100	15	3	31·2
I. ..	2,001 and more	103	..	..	100	15	3	31·2

**Vote.*—Figures for occasional consumption of milk have been included by calculation from the amount of milk purchased by a family during a week or a fortnight.

Graph 2 below has been constructed from the above table to show the daily *per capita* consumption of milk by different grades of society. The various income groups are shown along the *X* axis and the daily *per capita* consumption of milk in chhataks, is represented along the *Y* axis. The different lines running perpendicular to *OX* depict consumption per head for the Groups A., B., C., etc., marked at the base.

GRAPH 2.

GRAPH SHOWING DAILY PER CAPITA CONSUMPTION OF MILK BY DIFFERENT GRADES OF SOCIETY AT LAHORE.



As represented in the graph the curve rises from Group A. to C., the rise being higher from A. to B. than from B. to C. After C., the rise is comparatively steady up to F., from where it becomes most marked up to G.

From G. onwards it runs horizontally showing that the consumption of milk has reached satiation point.

From the above it is clear that—

(*a*). The consumption of milk is very low in the first two groups when the monthly income is Rs. 50/- or less, being from about 1½ chhataks to a little below 5 chhataks.

(*b*). There is a steady rise in the consumption of milk in groups with monthly incomes from Rs. 50/- to Rs. 500/- and this rise is still more prominent in the group between Rs. 500/- and Rs. 1,000/-.

(*c*). In the case of households with monthly incomes from Rs. 1,000/- upwards, *i.e.*, the richer classes, the consumption of milk is practically uniform, *viz.*, additional incomes beyond Rs. 1,000/- per month do not bring about any corresponding increase in the consumption of milk. *

Persons following the 'learned professions' are the heaviest consumers of milk and among these, college lecturers rank first, the consumption in their families being 16 chhataks 2 tolas per head, and then doctors (with 10 chhataks 1 tola per head).

The student community is an important section of the Lahore population. Information regarding them was gathered from the boarders of seven local colleges. The daily consumption of milk by an average college boy was found to be 9 chhataks 3 tolas. The corresponding figure for the girl students was 2 chhataks 4 tolas.† Most of the school students are day scholars and no separate figures are available regarding them. The local D.A.V. High School, however, maintains a large boarding house, and 4 chhataks of milk is served to every boarder daily.

At the lowest rung of the ladder stand the sweepers. Overworked and poorly paid, their milk consumption on an average comes to only 1 tola (0·4 ozs.) of milk each per day.

* An average member of this class consumes 71·2 gallons of milk in a year. This figure is higher than the average consumption per head of any of the Western countries (*vide* table on page 40).

† A circular letter was sent to all the local girl colleges and schools asking for information. Only one reply was received and this is the only source of our information for the girl students. According to this letter, 1,193½ seers of milk were consumed in all by the hostellers during the six months from November, 1929, to April, 1930. The Christmas and Spring vacations fell during this period. The number of residents was 46.

The following is the order in which the various classes may be placed in accordance with the amount of milk consumed by them :—

	Chhataks per day.
College lecturers Lawyers Doctors	10 to 16
Students Officials Big businessmen	6 to 10
Clerks Carpenters Small businessmen	4 to 6
Tailors Barbers Masons Blacksmiths Mechanics Office peons	2 to 4
Washermen Unskilled labourers Tonga drivers	1 to 2
Shoemakers Sweepers	Below 1

From the above it is clear that the well-to-do get more milk than the poorer people, so that the amount of milk used by the average citizen of Lahore is considerably less than 0·25 lb. per day.

It is a common belief that the Hindu consumes more milk than the Mohammedan. This seems to be based upon two assumptions: first, the Hindu sentiment of reverence for the cow and the sanctity attached by him to cow's milk, and second, the dietetic needs of the Hindus who, as a class, are vegetarians. By this statement it is not meant to relate the demand for milk to communal or racial characteristics; yet it would be interesting to record such conclusions on the point as are warranted from the material collected. The following table gives the amount of milk consumed per head by the various communities in each of the income groups :—

Daily Per Capita Consumption of Milk by Communities.

Communities.	Daily consumption of milk per head in tolas for the Different Income Groups								
	A.	B.	C.	D.	E.	F.	G.	H.	I.
All communities ..	7	23	30	34	40	50	78	78	78
Hindus ..	6	24	33	38	57	57	52	77	77
Mohammedans ..	8	19	25	20	40	41	44	..	84
Sikhs ..	..	30	31	26	..	60	47	88	..
Indian Christians ..	1	5	..	..	55	40	..	..	..
Europeans ..	..	..	..	..	60	45	65	53	40

Note.—Except in the case of the last two communities blank spaces indicate that less than ten cases were recorded for that group.

In this table composite figures for all communities are given in the first line. The figures for Hindus, lie in close vicinity of these figures in the case of four out of the nine income groups; in four they rise above them, the maximum deviation is 26 tolas on the negative side. The figures for Muslims rise above the composite figures only in two cases, agrees in one case and run below them in the remaining five groups, the maximum deviation being 34 tolas on the negative side. To compare directly, Hindus would seem to consume more milk than the Mohammedans, except in the lowest grade (income below Rs. 25/- per month) and perhaps in the highest grade (income above Rs. 2,000/- per month). The figures for Group H. were too few to generalise about. The Sikhs, though as a class non-vegetarians, are as large consumers of milk as the Hindus; in three out of the six income groups they consume more milk than Hindus and nowhere do their figures go as low as those of Mohammedans. The figures for Christians could not be collected in numbers large enough to justify comparisons.

Factors affecting the Demand for Milk.

So far, in studying the "demand for milk" reference has been made only to the classification of consumers. Something, however, should be said about the variations in and the factors affecting the demand for milk. A study of this nature requires as its basis statistical tables carefully collected

over a long period relating to the daily total production of milk, the number of effective purchasing families in the city, the quantities purchased by them and the figures for retail prices of milk and milk products. Unfortunately no such material is readily available in this country. Only a few dairies keep regular records of their daily business and the meagre information collected from this source is not of much use since the dairies supply milk only to a small portion of the city population and even that part is, in no way, representative of the whole; the customers of the dairies belong mainly to the upper middle and the richer classes. Under such circumstances any definite, consolidated, figures cannot be given on the subject. What is given below is based upon the information collected verbally from a large number of families on the one hand, and *gujars, gowalas* and *halwais* on the other. It may be added that only those points have been included as were acknowledged to be true by both consumers and producers as two distinct classes.

Variations in the demand for milk may be put into two groups—(*a*). *regular or recurring variations,* and (*b*). *irregular or intermittent fluctuations.*

Those in the first group include seasonal variations, periodic changes and variations due to festivals. Since the exact time at which any one of these variations will occur is known, some estimate of the demand can be made well in advance. The second group of variations arises from highly uncertain factors, such as sudden changes in temperature, unexpected rainfall and other unforeseen things. These factors operate over short periods only and have a speedy effect on sales. Different factors working at the same time produce irregular effects on the sales, at times counteracting and at times supplementing each other. It is, therefore, proposed to trace the line of effect of each cause separately.

(*a*). *Regular or recurring variations.*

(*i*) *Long-time trend in demand.*—The total amount of milk sold daily in Lahore was estimated at 733 maunds in 1916*; in 1921 it was estimated at 666 maunds†; and according to the present inquiry the total daily sale of milk in the Lahore Municipal area may be put at 1,207 maunds. The following table shows the daily *per capita* consumption of milk for the

* 'Notes on Dairying' by Bh. Kartar Singh, p. 2. The exact figure is 60,114 lbs.
† 'Milk Supply of Lahore in 1921,' by Shiva Datta, p. 7. The exact figure is 26,637 seers.

years 1915, 1921 and 1930 in the city of Lahore :—

Daily Per Capita Milk Consumption in Lahore in Different Years.

Year.	Population of Lahore.	Total amount of milk consumed.	Per capita per diem consumption in—	
		Mds.	Chhataks.	Equivalent in lbs.
1916 ..	210,787*	733	2·16	0·27
1921 ..	257,295	666	1·68	0·21
1930 ..	400,075†	1,207	1·93	0·25

(*ii*). *Seasonal variations in demand.*—These are due to two factors : (*a*). migration of people from Lahore during summer months, and (*b*). temperature changes of the seasons. Quite a large number of the six thousand students studying in the different arts and professional colleges and also many well-to-do families, go out of Lahore during the summer vacation. The closing of the courts and transfer to Simla of certain Government offices also takes place in this season, hence the demand for milk falls considerably especially during the three months of July, August and September. On the other hand the scorching heat of the sun in the summer days encourages the use of cold drinks, the need for which is felt all the more by poorer people doing hard manual labour. *Lassi* (milk or curd and water), essentially the summer beverage of the Punjabis, is used by almost all people in summer. There are many among the lower ranks who do without milk or tea during winter, but *lassi* is almost the last thing a Punjabi would forego during summer and more milk is required to prepare *lassi* than to make tea. The resulting effect of these two factors is that although the total demand for milk in Lahore falls during the summer months, the consumption per head increases.

(*iii*). *Periodic changes and fluctuations due to festivals.*—During the month of Ramzan most of the Mohammedans observe a fast. A little before dawn they take sufficient food to sustain them through the day, and then break their fast about dusk. On both occasions milk is used freely and

* This figure really refers to the census figure of 1911, but is used by Bh. Kartar Singh in his monograph of 1916.

† 1931 census figure.

there is a common complaint of scarcity of milk during this month. A similar period of high demand occurs during the fortnight called '*shradh*,' during which the Hindus make offerings to the memory of their departed elders by feeding the Brahmans and the poor on *khir* (rice cooked in milk), and this uses up a large quantity of milk in its preparation. Further, *navratas* (days preceding the festival of Dussehra), impose a great strain on the existing supply, though compared with the two periods just mentioned this is of secondary importance. There are also several other religious and social festivals at different times of the year when the chief product consumed is milk and its various preparations : the more important among these are *Janam ashtmi*, *Karwa chauth*, *Diwali*, *Tukri*, *Amavas* and *'Id-ul-fitr*.

(*b*). *Irregular or intermittent fluctuations.*

These are numerous, short-time fluctuations due to sudden climatic changes and other unforeseen occurrences like *hartals*, *i.e.*, sudden suspension of business, or fasting. A change in temperature produces a corresponding effect in the sale of milk. This is most marked in the retail sales in the bazar by *halwais*. An extraordinarily hot day means an increase in the sale of milk, whereas the *halwais* convert the spare milk left with them after a heavy shower of rain when the demand goes down with the mercury, into *khoya* or sweetmeats, which keep longer than milk.

CHAPTER IV.

PRICE OF MILK.

Milk, as compared with other commodities, possesses the following peculiarities :—

1. In its natural state it is a very perishable product ; it spoils even more quickly than fresh fruits. Further, milk which has gone bad becomes unfit for further use and this means a dead loss to the owner. For the same reason, it cannot be carried over long distances by the methods of transport and storage at present prevalent ; the producers and dealers cannot accumulate stocks to be disposed of at later periods, and consequently they have to exercise judgment in regulating their supplies. Under these conditions, maladjustments between the demand and the supply are therefore not of infrequent occurrence in the milk trade.

2. As regards quality, milk is a highly variable product. Although milk from different species of mammals contains practically the same constituents, the proportions of these vary within very wide limits. Fat is the most variable factor, proteins come next in importance, while sugar is less variable and ash is relatively constant. Variability in the composition of milk is, by no means, confined to differences in species ; in fact, there are certain other conditions and factors which are also responsible for variations in the composition of different samples within the same species, such as (*a*). breed, (*b*). individual character, (*c*). age and health, (*d*). lactation period, (*e*). food, (*f*). comfort and exercise, (*g*). season, weather and temperature, (*h*). time of milking and skill of the milker, and (*i*). adulteration. Since the food value of milk is proportionate to the amount of solids present in it, variability in its composition is a subject of great economic importance, especially in connection with the determination of its value for feeding infants. Furthermore, the very fact that milk varies in its composition even under normal conditions, renders detection of adulteration rather difficult.

3. Milk, perhaps amongst all common articles of human diet, can be adulterated most easily. The " bucket of clear net profit " (see Frontispiece) in the form of water is always near at hand to both the producer and the retailer. This mischief can neither be easily detected by the customers nor punished by law. Marketing of partially skimmed and diluted milk is not an unusual practice. The legal standards as to the chemical quality of milk as fixed by the Chemical Examiner to the Punjab Government in 1925 refer to the lowest limits of percentages of milk-fat and non-fatty solids in milk, that are allowed in market milk. As such, they give a long rope to the milk producers and dealers.

4. By virtue of its opacity and other physical characteristics milk can contain a large number of harmful and pathogenic bacteria, like the causal organisms of tuberculosis and cholera, without changing its normal

external appearance, and still be passed on to the unsuspecting public for consumption with grave results. Under existing conditions, even milk from animals suffering from the active form of tuberculosis is being mixed with large quantities of good milk and sold freely to the public. There are no existing laws which could effectively stop trafficking in such dangerous milk.

5. Milk is not a manufactured article. One cannot open a tap to obtain an increased supply and then turn it off when the demand is satisfied. On the contrary, milk is produced by an animal who avails herself to the fullest extent of the caprice attributed to her sex. Moreover, her yield is materially affected by climate and other conditions. Therefore, any attempt to fix prices over a period must necessarily be somewhat of a gamble.

From its very nature the milk market in Lahore and other large towns has hardly any organisation and regularity about it such as one finds in the case of other staple commodities; and although its price tends to be competitive, there is great variance in the rates at which milk sales are effected. Below are given the rates at which annual contracts for milk in 671 cases, which were noted in a shop to shop inquiry, were made between the *halwais* and *gujars* in the month of *Maghar* (November-December) of 1929.

Statement showing Wholesale Rates of Milk prevalent in Lahore.

Wholesale rates per maund (of 50 seers).	Number of contracts made at these rates.	
	Cow's milk.	Buffalo milk.
Rupees Annas		
6 0 ..	1	..
6 8 ..	4	..
6 12 ..	9	..
7 0 ..	16	..
7 4 ..	16	..
7 8 ..	17	7
7 12 ..	10	10
8 0 ..	62	24
8 4 ..	6	14
8 8 ..	24	28
8 12 ..	10	22
9 0 ..	68	131
9 4 ..	3	31
9 8 ..	3	29
9 12 ..	1	113
10 0 ..	2	4
10 4 ..	..	2
10 8 ..	..	4
Total ..	*252*	*419*

During this shop to shop inquiry, rates at which milk was being sold were also ascertained from the *halwais* ; these are classified below :—

Statement showing Retail Rates of Milk prevalent in Lahore.

Rate per seer.		Number of halwais selling at this rate.		
		Cow's milk.	Buffalo milk.	Heated milk.
Annas	Pies			
2	6	1	..	..
3	0	74	12	1
3	3	16	1	..
3	6	193	62	..
3	9	..	3	1
4	0	82	311	234
4	6	1	6	19
5	0	..	..	133
6	0	..	..	1
Total ..		*367*	*395*	*389*

In spite of the great divergence in rates, certain points can be located round about which most of the transactions are carried on, and these may, with a certain amount of accuracy, be termed the " market rates " for milk. It may be said then that the wholesale rates of milk were Rs. 8/8/0 and Rs. 9/8/0 per *pacca* maund for cow's and buffalo milk, respectively, and the retail rates Rs. 0/3/6 per seer for fresh cow's milk, Rs. 0/4/0 for buffalo and Rs. 0/4/6 for heated milk.

Annual variations in the price of milk.—The table on the next page gives the annual retail and wholesale prices of the different kinds of milk since 1904, which year has also been taken as the base for the index numbers shown in the table.

The period between 1904 and 1930 may be divided into two parts—(*a*). 1904 to 1921, during which years milk prices show an upward tendency, and (*b*). 1921 to 1930, which period is marked by a steady decline. Official records are not available for the milk prices between 1904 and 1914. All that we know is that by 1914 wholesale prices had risen from 100 to 181·5 and retail prices to 144. From 1914 to 1918 the rise in prices was gradual; in 1918 they stood at 245 (wholesale) and 187·5 (retail). During the next three years prices rose rather rapidly, till in 1921 they were approximately twice as high as in 1918 and about four times

Annual Milk Prices from 1914 to 1930 as compared with the Price in 1904.

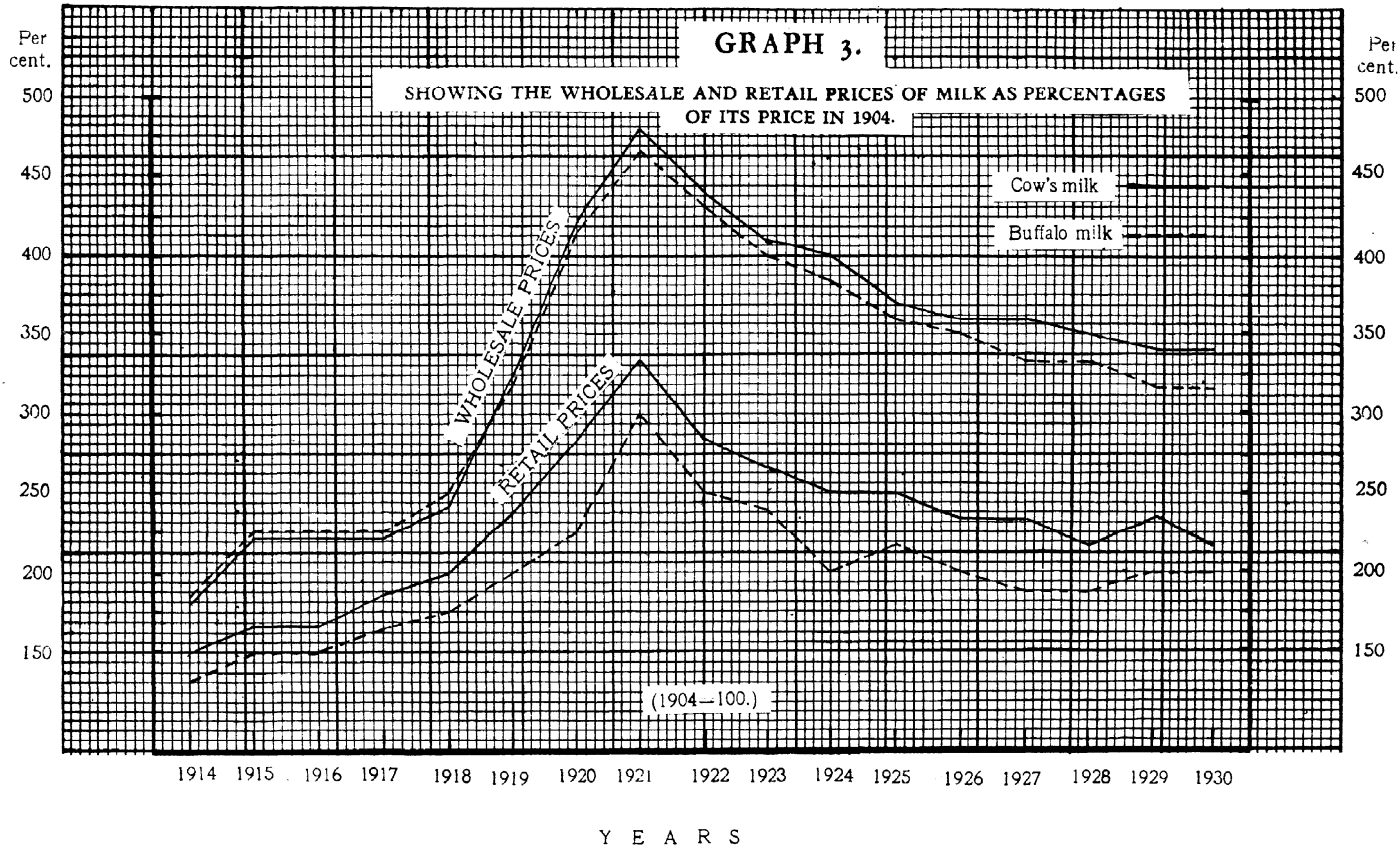
Year.	Retail prices per seer of 16 Chhataks.					Wholesale prices per maund of 100 lb.				
	Cow's milk.		*Buffalo milk.*		Average of cols. 3 & 5.	*Cow's milk.*		*Buffalo milk.*		Average of cols. 8 & 10.
	Price.	Index No.	Price.	Index No.		Price.	Index No.	Price.	Index No.	
1	2	3	4	5	6	7	8	9	10	11
	As. p.		As. p.			Rs. a.		Rs. a.		
1904 ..	1 6	100	2 0	100	100·0	2 8	100	3 0	100	100·0
1914 ..	2 3	150	2 9	138	144·0	4 8	180	5 8	183	181·5
1915 ..	2 6	167	3 0	150	158·5	5 8	220	6 12	225	222·5
1916 ..	2 6	167	3 0	150	158·5	5 8	220	6 12	225	222·5
1917 ..	2 9	183	3 3	163	173·0	5 8	220	6 12	225	222·5
1918 ..	3 0	200	3 6	175	187·5	6 0	240	7 8	250	245·0
1919 ..	3 6	233	4 0	200	216·5	8 0	320	9 8	317	318·5
1920 ..	4 0	267	4 6	225	246·0	10 8	420	12 8	417	418·5
1921 ..	5 0	333	6 0	300	316·5	12 0	480	14 0	467	473·5
1922 ..	4 3	283	5 0	250	266·5	11 0	440	13 0	433	436·5
1923 ..	4 0	267	4 9	237	252·0	10 4	410	12 0	400	405·0
1924 ..	3 9	250	4 0	200	225·0	10 0	400	11 8	383	386·5
1925 ..	3 9	250	4 3	212	231·0	9 4	370	10 12	358	364·0
1926 ..	3 6	233	4 0	200	216·5	9 0	360	10 8	350	355·0
1927 ..	3 6	233	3 9	187	210·0	9 0	360	10 0	333	346·5
1928 ..	3 3	217	3 9	187	202·0	8 12	350	10 0	333	341·5
1929 ..	3 6	233	4 0	200	216·5	8 8	340	9 8	317	328·5
1930 ..	3 3	217	4 0	200	208·5	8 8	340	9 8	317	328·5

Note 1.—Figures from 1904 to 1921 have been reproduced from Shiva Datta's 'Milk Supply of Lahore in 1921,' p. 30.

Note 2.—The retail price figures from 1921 onwards are taken from the local *Tahsil* records, while the wholesale price figures have been obtained from the *bahis* (account books) of a number of *halwais*.

those of 1904, the index number for 1921 being 473·5 (wholesale) and 316·5 (retail). Since 1921 there has been a continuous fall in the wholesale prices the index number in 1929 touching 328·5, *i.e.*, practically reverting to the level of 1919. During the year 1930 (January to September) the prices remained more or less the same as in 1929, but on the renewal of *bandh* rates in November a further fall was anticipated. The trend of retail prices has been similar. From 310·5 in 1921, the index number steadily declined to 252, 231 and 210 in the years 1923, 1925 and 1927, respectively. In 1928 the figure fell to 202, rose to 216·5 in 1929 to fall again to 208·5 in 1930.

Graph No. 3 shows the wholesale and retail prices of milk from 1914 to 1930, expressed as a percentage of the milk prices in 1904. A study of this graph and the foregoing table shows that for wholesale rates later than 1919 and retail rates since 1914, the index numbers of cow's milk at each stage stand higher than those for buffalo milk.


GRAPH 3.
SHOWING THE WHOLESALE AND RETAIL PRICES OF MILK AS PERCENTAGES OF ITS PRICE IN 1904.
Per cent.
500
450
400
350
300
250
200
150
Cow's milk
Buffalo milk
WHOLESALE PRICES
RETAIL PRICES
(1904—100.)
1914 1915 1916 1917 1918 1919 1920 1921 1922 1923 1924 1925 1926 1927 1928 1929 1930
YEARS

The following explanation of this may be hazarded. It has already been pointed out that the supply of cow's milk has not kept pace with that of buffalo milk. In Lahore the increase in the number of buffaloes has been greater than in the number of cows, and in the villages buffaloes are rapidly replacing the cows.* On the demand side it is believed that the artificial feeding of infants has been more popular than previously, especially among the upper classes, and for this purpose cow's milk is always preferred to buffalo milk because of its more suitable composition.

Year to year variations in the wholesale prices are, on the whole, larger than the variations in the retail prices. That the retail prices do not keep pace with the wholesale prices may be seen generally from the price curves in Graph No. 3, and this is also shown in the following table:—

Extent of Annual Deviation in the Index Numbers of Milk Prices beginning with the deviation of the Year 1915 from the Year 1914. (1904=100).

Prices.	1915.	1916.	1917.	1918.	1919.	1920.	1921.	1922.	1923.	1924.	1925.	1926.	1927.	1928.	1929.	1930.	Total.
Wholesale.	41·0	..	..	22·5	73·5	100·0	55·0	*37·0*	*30·5*	*18·5*	*22·5*	*9·0*	*8·5*	*5·0*	*13·0*	..	436
Retail	14·5	..	14·5	14·5	29·0	29·5	70·5	*50·0*	*14·5*	*27·0*	6·5	*14·5*	*6·5*	*8·0*	14·5	*8·0*	310

Note.—Figures in italics show a negative deviation.

The wholesale prices are more sensitive in reflecting industrial and trade conditions than retail prices. The element of competition is more prominent in wholesale transactions, whereas the element of custom preponderates in retail dealings.

Prices of milk and food grains.—A comparison of the milk price variations with those in the price of food grains is suggestive. In the first column of the following table is given the index number of food grains, with the quinquennium 1890-94 as the basic period. The second column shows the index number of milk, *i.e.*, arithmetic average of the prices of different kinds of milk expressed as percentages of the corresponding prices obtaining in 1904 : heated milk has been left out of consideration. To correlate the two sets of figures by reducing them to a common base,

* Cows and buffaloes in Lahore municipal area in different years were :—

	1916		1921		1930	
	No.	*Per cent.*	*No.*	*Per cent.*	*No.*	*Per cent.*
Cows ..	3,077	74·0	3,896	71·5	3,798	67·7
Buffaloes ..	1,083	26·0	1,551	28·5	1,813	32·3

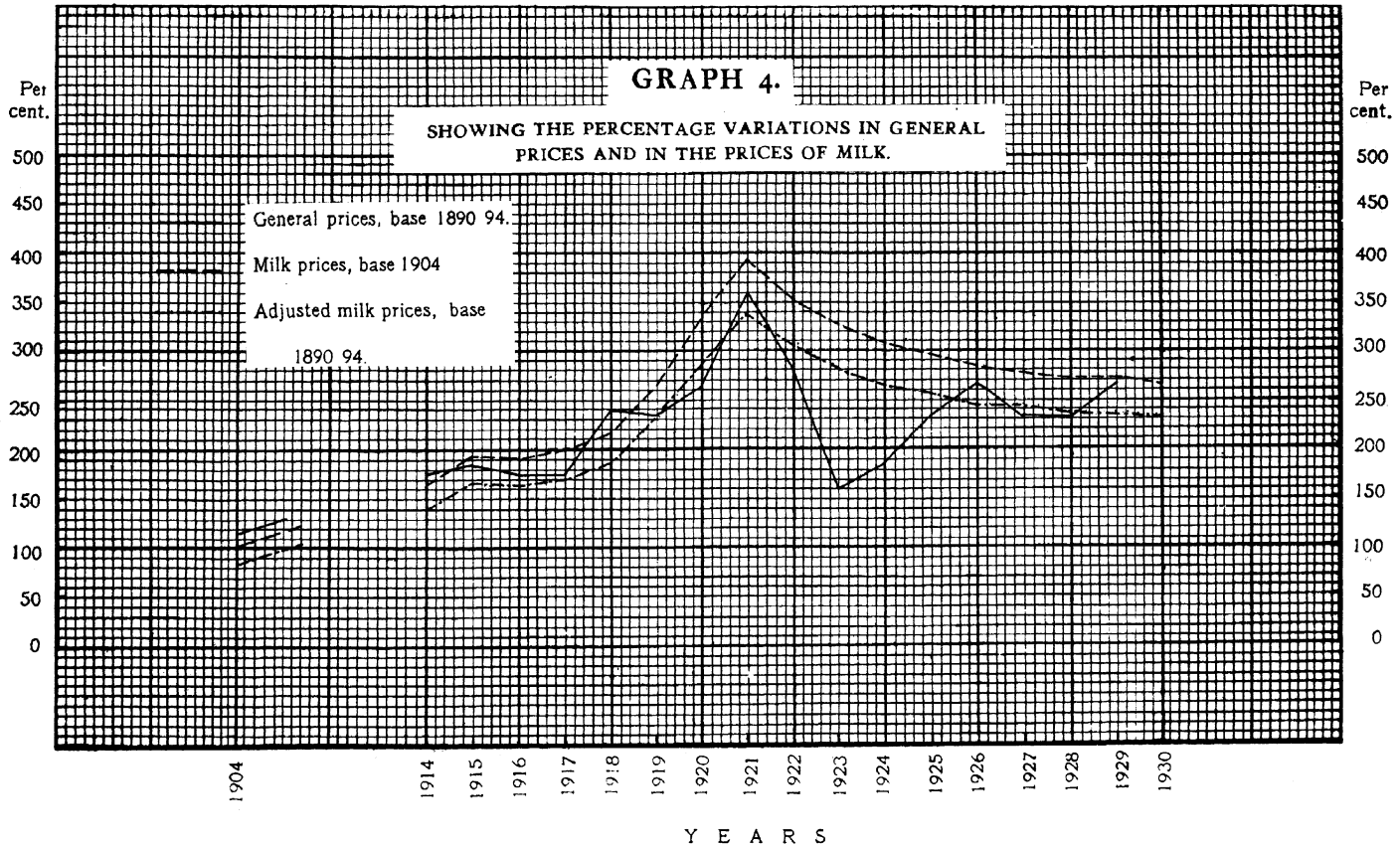
the following method has been adopted. In the index number of milk (column 3), the price of milk against the year 1904 has been assumed to be 100. But the general index number shows that in this year general prices were 16 per cent. higher than those of the quinquennium 1890-94. Therefore, the whole set of figures in column 3 has been multiplied by 100/116, and the new series thus obtained is shown in column 4 as 'adjusted index number of milk' with the basic period, the quinquennium 1890-94. This procedure may be open to objection from the statistical standpoint, but it has been adopted simply to make rough comparisons. The results are also shown in Graph No. 4.

Index Numbers of Food Grains and Milk Prices.

Year.	General Index No. of food grains* (1890-94=100.)	Index No. of milk (1904=100.)	Adjusted Index No. of milk (1890-94=100.)
1	2	3	4
1904 ..	116	100	86
1914 ..	176	163	140
1915 ..	185	191	164
1916 ..	175	191	164
1917 ..	175	198	170
1918 ..	240	216	186
1919 ..	234	268	230
1920 ..	262	332	284
1921 ..	361	395	340
1922 ..	279	352	303
1923 ..	160	329	283
1924 ..	187	306	264
1925 ..	234	298	257
1926 ..	266	286	246
1927 ..	234	278	240
1928 ..	231	272	235
1929 ..	267	273	235
1930 ..	..	269	231

In the words of Prof. Brij Narain, "The general average for the quinquennium 1895-99 was 28 per cent. higher as compared with the basic period 1890-94. It fell in 1900-04 but then rose continuously until in 1920-24 the index number stood at 251. In the last quinquennium the general average fell to 246 or as compared with the basic period, prices were 146 per cent. higher."*

* Report of the Punjab Provincial Banking Enquiry Committee, Vol. I., pp. 166-67.


GRAPH 4.
SHOWING THE PERCENTAGE VARIATIONS IN GENERAL PRICES AND IN THE PRICES OF MILK.
General prices, base 1890 94.
Milk prices, base 1904
Adjusted milk prices, base 1890 94.
Per cent.
500
450
400
350
300
250
200
150
100
50
0
1904
1914
1915
1916
1917
1918
1919
1920
1921
1922
1923
1924
1925
1926
1927
1928
1929
1930
YEARS

Comparing the two sets of figures pertaining to food grain prices and milk prices a resemblance between them may be noted, although owing to the highly elastic demand for milk, its price feels those influences which affect the price of food grains to a slighter extent. Milk prices rose with the general prices up to 1921. In 1922 the price of food grains fell heavily causing a disparity between the two, but this was eventually balanced in 1925.

Beyond the influence of the general level of prices which affects the price of milch cattle, the cost of maintaining them and the general purchasing power of the people, there has been no remarkable change in other factors affecting the price of milk. The same time-worn methods of feeding and management of cattle, and adulteration and distribution of milk are followed even to-day; nor has there been any remarkable change in the habits of the people regarding the use of milk.

Seasonal variations in milk prices.—In the chapters on the "Demand for Milk" and the "Supply of Milk," the question of seasonal variations has already been discussed in some detail. The intensity of the demand and supply of milk at current prices in the various months of a year may roughly be expressed as follows :—

Monthly Demand and Supply of Milk in Lahore.

Month.	Demand.	Supply.	Remarks.
October ..	Great ..	Not sufficient ..	Demand much in excess of supply.
November ..	Do.	Do. ..	
December ..	Do. ..	Sufficient ..	Demand moderately in excess of supply.
January ..	Do. ..	Do. ..	
February ..	A little depressed ..	Slight decrease ..	
March ..	Do. ..	Do. ..	Demand much in excess of supply.
April ..	Do. ..	Insufficient ..	
May ..	Very great ..	Do. ..	Demand very much in excess of supply.
June ..	Do. ..	Do. ..	
July ..	Comparatively less ..	Do. ..	Demand moderately in excess of supply.
August ..	Do. ..	Slight increase ..	
September ..	Do. ..	Do. ..	

The unsatisfied demand for milk should express itself through higher prices and more frequent adulteration. As already pointed out, retail prices are not very sensitive to the influences of demand and supply. The following statement gives the monthly retail prices for different kinds of milk for the last two years: because of contracts wholesale prices are mostly fixed for the year (*cf.* p. 68).

Retail Prices per seer of Milk in Lahore.

Month.	October 1928 to September 1929.			October 1929 to September 1930.		
	Cow's milk.	Buffalo milk.	Heated milk.	Cow's milk.	Buffalo milk.	Heated milk.
	As.	As.	As.	As.	As.	As.
October ..	3½	4½	5	4	4	5
November ..	3½	4	5	3½	4	5
December ..	3¼	4	5	3	4	5
January ..	3½	4	5	3	4	5
February ..	3½	4	5	3½	4	5
March ..	3½	4	5	3½	4	5
April ..	3½	4	5	3¼	4	4¾
May ..	3½	4	5	3¼	3½	5
June* ..	3	3½	5	3	3½	4
July ..	3	3½	4½	3½	4	5
August ..	3	3½	4½	3	4	5
September ..	4	4½	5	2½	3	4

* The comparatively lower retail price of milk in June in spite of the greater demand and lack in supply may be explained by the increase in the intensive and extensive adulteration practised.

The results of chemical analyses of milk done in the Lahore Municipal Laboratory are summarised in the table on the next page and show that the percentage amount of adulteration and the percentage of adulterated samples follow the same course as the unsatisfied demand for milk during the various months. Graph No. 5 prepared from this table shows the percentage of adulterated samples to the total number of samples examined and the average percentage adulteration with water. In May, June and October, the unsatisfied demand is at a very high level, and these are the months when adulteration is most common. In December, January and February the unsatisfied demand is comparatively low, accompanied by lower figures of adulteration.

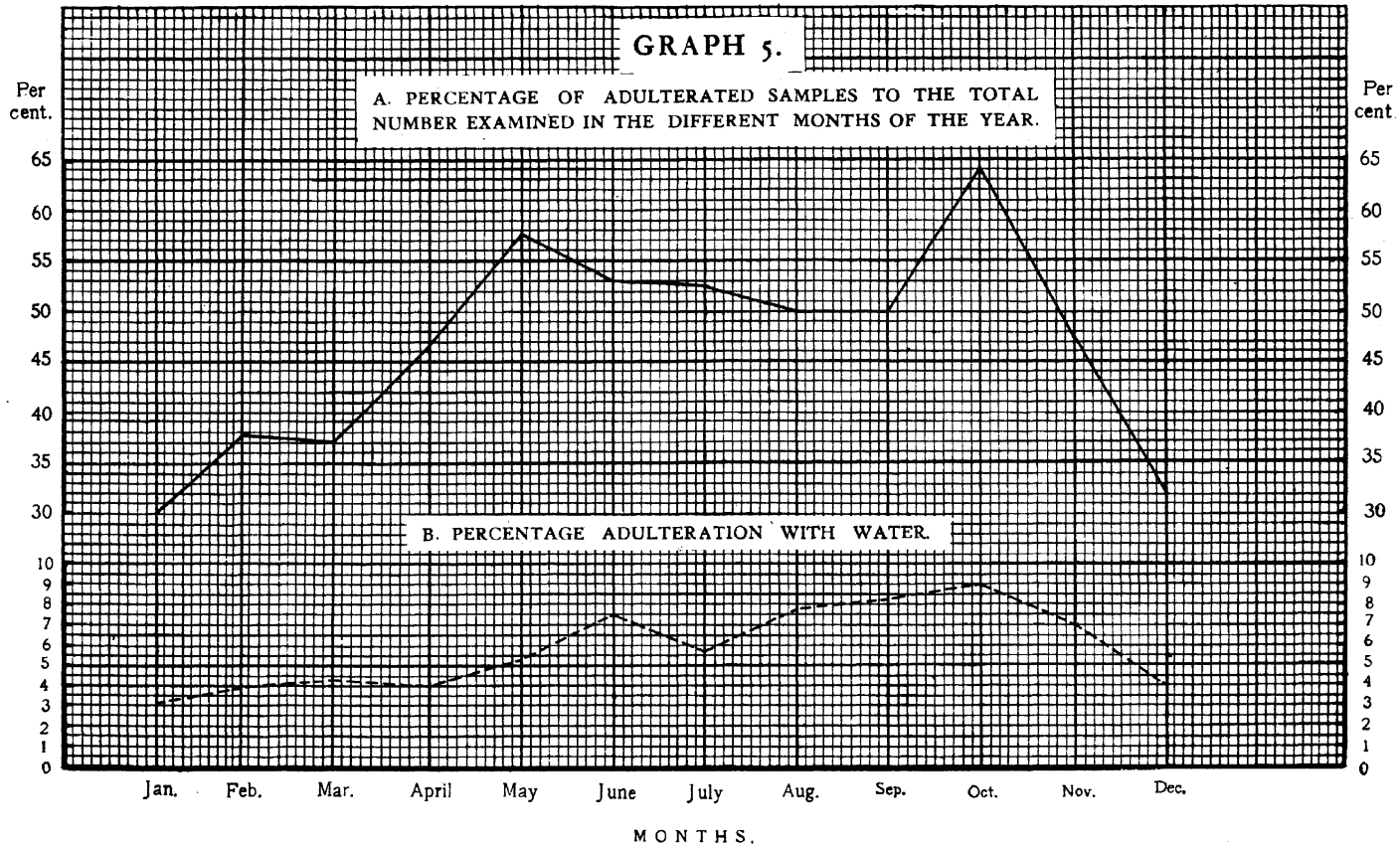

GRAPH 5.
A. PERCENTAGE OF ADULTERATED SAMPLES TO THE TOTAL NUMBER EXAMINED IN THE DIFFERENT MONTHS OF THE YEAR.
B. PERCENTAGE ADULTERATION WITH WATER.
Per cent.
Per cent.
65
60
55
50
45
40
35
30
10
9
8
7
6
5
4
3
2
1
0
Jan.
Feb.
Mar.
April
May
June
July
Aug.
Sep.
Oct.
Nov.
Dec.
MONTHS.

Table showing the Extent of Adulteration of Milk sold in Lahore.

Months.	Total Number of samples examined.	Average percentage of water used in adulteration.		Number of samples found adulterated with more than 8 per cent. water.	Percentage of adulterated samples to the total number examined.	
October 1927 ..	62	5·0		16	43·2	
,, 1928 ..	37	9·6	8·9	23	81·0	64·0
,, 1929 ..	119	12·3		60	68·0	
November 1927 ..	60	6·9		18	48·3	
,, 1928 ..	51	6·5	7·0	16	58·8	47·5
,, 1929 ..	132	7·7		42	35·6	
December 1927 ..	29	..		4	31·0	
,, 1928 ..	77	4·7	3·9	16	42·8	32·2
,, 1929 ..	113	3·2		13	23·0	
January 1927 ..	102	2·3		10	27·4	
,, 1928 ..	139	3·5	3·2	19	30·9	30·2
,, 1929 ..	98	4·9		23	43·9	
,, 1930 ..	132	2·4		18	18·9	
February 1927 ..	189	2·3		16	21·6	
,, 1928 ..	157	5·5	3·8	36	54·1	37·4
,, 1929 ..	130	4·1		27	40·8	
,, 1930 ..	51	3·4		12	33·3	
March 1927 ..	183	1·6		14	24·5	
,, 1928 ..	14	8·2	4·1	5	57·1	37·1
,, 1929 ..	108	4·6		23	39·8	
,, 1930 ..	95	2·0		11	27·3	
April 1927 ..	91	3·5		12	42·8	
,, 1928 ..	..	..	4·0	..	..	46·5
,, 1929 ..	102	4·9		20	54·9	
,, 1930 ..	31	3·6		5	41·9	
May 1927 ..	99	3·8		11	39·2	
,, 1928 ..	..	..	5·2	..	..	57·5
,, 1929 ..	54	6·6		23	75·9	
,, 1930 ..	..	..		..	..	
June 1927 ..	44	5·4		12	38·6	
,, 1928 ..	8	7·7	7·5	2	50·0	53·0
,, 1929 ..	52	13·4		22	61·5	
,, 1930 ..	50	3·8		23	62·0	
July 1927 ..	..	..		..	..	
,, 1928 ..	112	6·8	5·6	35	47·3	52·7
,, 1929 ..	113	5·9		36	61·0	
,, 1930 ..	42	4·2		10	50·0	
*August 1927 ..	147	3·5		27	38·0	
,, 1928 ..	33	10·7	7·7	22	51·8	50·2
,, 1929 ..	130	9·1		40	60·9	
*September 1927 ..	81	7·5		13	50·6	
,, 1928 ..	23	8·1	8·3	12	39·1	49·9
,, 1929 ..	70	9·4		27	60·0	

*The high adulteration figures in the months of August and September may also be partly due to the abundance of green fodder in these months, when milk gets thinner to a certain extent.

Note.—A blank indicates that information was not available.

CHAPTER V.

PEOPLE ENGAGED IN THE MILK TRADE.

1.—Professional milch cattle keepers.

According to a special inquiry conducted with the help of the Municipal Health Department, the following figures were obtained regarding the number of families in Lahore, who were mainly dependent for their livelihood on the milch cattle kept by them :—

Castes.	*Families.*	*Castes.*	*Families.*
Gujars	.. 181	*Balochs*	.. 3
Telis	.. 40	*Julahas*	.. 3
Jats	.. 39	*Machhis*	.. 3
Gowalas	.. 26	*Nais*	.. 3
Mashkis	.. 15	*Sheikhs*	.. 3
Aroras	.. 13	*Sayeds*	.. 2
Arains	.. 11	*Lalaris*	.. 2
Changars	.. 10	*Khatris*	.. 2
Rajputs	.. 9	*Banias*	.. 1
Kashmiris	.. 5	*Mirasis*	.. 1
Brahmans	.. 4	Unspecified	.. 2
	Total No. of families	.. *378*	

In the year 1921, the total number of professional milch cattle keepers, above the age of 10 years, was estimated to be 779,* divided among the following castes :—

	Number.		*Number.*
Gujars	.. 505	*Sayeds*	.. 5
Gowalas	.. 96	*Bhatras*	.. 2
Jats	.. 55	*Lalaris*	.. 2
Telis	.. 33	*Bharwals*	.. 2
Changars	.. 14	*Tarkhans*	.. 1
Khatris	.. 14	Persons belonging to Criminal Tribes and Jails	.. 24
Arains	.. 13		
Mashkis	.. 7		
Brahmans	.. 6		
	Total	.. *779*	

* 'Milk Supply of Lahore, 1921,' by Shiva Datta, p. 7.

Generally speaking in the study of economic problems it is considered desirable to take the family and not the individual worker as the unit. Further, the placing of the age-bar at 10 years is perhaps rather arbitrary, since among the class of professional milch cattle keepers children from six or seven years onward begin to help their parents in the milking and general management of cattle. They, however, are not allowed to milk the cattle or to take them out to graze alone till they are about fourteen years of age. So, even if the number of 'workers' were required to be shown, the age-bar would more appropriately have been placed either at 7 or 14 years. No direct comparison is, therefore, possible between the two sets of figures referring to the professional milk-men in Lahore in 1930 and 1921.

With the loosening of the bonds of the caste-system, people have begun to adopt trades and professions more according to their own liking and choice, rather than to follow those of their forefathers. In the milk industry, as in many others, the less efficient hereditary workmen are being ousted and replaced by more efficient outsiders. The *gujar* is still predominant in the milk trade, but his dominance is being threatened by the entry into this trade of people from other classes. Taking the number of workers to be proportional to the number of families, it is calculated that whereas the *gujars* formed 65 per cent. of the total number of families in 1921 who were dependent upon the milk industry, in 1930 their strength had been reduced to 48 per cent. In 1921 the *gowalas* stood next in importance to the *gujars*, but by 1930 they had been superseded by the more energetic classes of *Jats* and *Telis*. This illustrates how fast the once iron grip of the caste-system is losing its hold on the minds of the people.

The *gujars* among the Mohammedans and the *gowalas* among the Hindus are hereditary followers of the milk profession, so much so, that any person who keeps milch cattle for the production of milk is given these names. Literally both the words, *gowala* and *gujar*, mean 'the keeper of cows.' In Lahore the *gowalas* have gathered together in one locality, now called after their name '*gowalmandi.*' The *gujars*, however, are scattered all over the city, quite a large number of them living and keeping their cattle along the older city borders between the city wall and the city drain.

In the herds kept by *gowalas* it is very rare to see a buffalo. The *gujars*, however, keep mixed herds. *Ahirs* or *gowalas* seem to be best

suited for keeping cows, while *gujars* do better with buffaloes. As a rule, *Ahirs* keep smaller herds and are expert at milking cows with smaller teats, but they are not so skilful as the *gujars* in handling the larger teats of buffaloes. The *gujars* possess strong wrists and have a way of milking animals which is decidedly superior to that of the *gowalas*. They hold the teat with the whole hand and with the fingers closing round press it against the palm, whereas the *gowalas* grasp the teat with four fingers closing round it and work with the thumb doubled inside the palm of the hand. The latter practice is pernicious, because " heavier and unequal pressure is exerted at a point high up on the teat which is often bruised or permanently injured. Sore teats and thickening of the milk duct at that point ultimately leading to complete obstruction or blocking of the outlet is not an infrequent result."*

The gujars.—A passing reference as to the origin of the *gujars* may be of some interest here. They trace their descent from a powerful sub-caste of the Rajputs having their original home somewhere near Delhi. During the reign of the Choghattas, their small kingdom was subjugated and they had perforce to move into the Punjab, where they settled in small colonies, and the present familiar names of Gujrat, Gujranwala, Gujarkhan, are reminders of those times. As time went on they were converted to Islam. Why they abandoned agriculture in favour of dairying is still unknown. Figures 6 and 7 show typical *gujars*.

In the Lahore district the *gujars* have been classed among the non-agricultural tribes, and are thus banned from purchasing land from the agriculturists except by special permission. This, indeed, is a great handicap to them in their trade. In view of the fact that rents inside the city are very high, and the green fodder, which they require daily in large quantities, sells at very high rates, a large number of the *gujars* might move their cattle to the neighbouring villages if they could purchase land to stall their cattle and grow their own fodder.

For the sake of brevity the term '*gujar*' has been used in this report to denote the professional milch cattle keepers in general, unless otherwise specified.

Size of milch cattle keeper's family.—An average family of this class in Lahore consists of 5·24 persons; of these 1·84 are men, 1·49 women and

* 'The Art of Milking,' by A. C. Aggarwala, p. 2. (Department of Agriculture, Punjab, Veterinary Bulletin No. 20, 1928.)

1·91 children below 14 years of age.* The following classifies the families according to their respective sizes :—

Table Classifying Milch Cattle Keepers' Families according to Size.

Number of persons in a family.	Number of families with the specified number of persons.	Percentage to total.
One ..	10	2·7
Two ..	49	13·2
Three ..	58	15·6
Four ..	51	13·7
Five ..	53	14·3
Six ..	51	13·7
Seven ..	27	7·3
Eight ..	22	6·0
More than eight ..	50	13·5
Total ..	*371*	*100·0*

In the above table it will be seen that there is a great diversity in the size of the families. Those consisting of from two to six people are to be found in about equal numbers. The largest family recorded consisted of 20 persons; a majority of the families consisting of six persons or more were, however, 'joint families,' or better 'joint households.'

Number of cattle owned by a milch cattle keeper.—The most important factor affecting the economic state of the professional milk-men is the small size of their herds. The total stock held by this class consists of 6,645 head of cattle, and this is divided into 378 separate herds according to the number of families; hence the number of cattle owned by an average cattle keeper in Lahore is 17·6. The cattle are classified below :—

			Number.
Bovine—			
Bulls			73
Cows, in milk	1,957	}	3,119
,, , dry	1,162	}	
Young stock			1,943
Buffaloes—			
Bulls			16
Cows, in milk	772	}	1,174
,, , dry	402	}	
Young stock			320
Total			*6,645*

*Of the 378 families of professional milch cattle keepers enquired into, full particulars regarding seven are not available. The total number of persons in 371 families was 1,949, of which 684 were men, 553 women and 712 children. A copy of the questionnaire according to which information was collected, is given in Form V., Appendix D., at the end of the book.

The number of cows and buffaloes in milk, and dry, is 4,293, and at the time of investigation, 2,729 cattle or 41·2 per cent. of the total stock were in milk. It follows, therefore, that an average cattle keeper has to feed 17 or 18 head of cattle, out of which only 7 give milk. The rest have nothing else but dung to offer, if the womenfolk care to prepare cakes (*uplás*) out of it.

The average given above does not give a comprehensive idea about the real condition of the keepers because the cattle are very unevenly distributed among the different families. The following table shows the distribution among the cattle keepers inside the city :—

Milch Cattle Keepers Classified according to the Number of Animals Kept.

Number of milch cattle per family.	Number of such families.	Percentage of such families to the total number.
Up to 4 animals	63	16·7
5 to 8 ,, ...	64	16·9
9 to 12 ,, ...	56	14·8
13 to 16 ,, ...	45	11·9
17 to 20 ,, ...	41	10·8
21 to 24 ,, ...	27	7·2
25 to 28 ,, ...	27	7·2
29 to 32 ,, ...	23	6·1
33 to 36 ,, ...	8	2·1
37 to 40 ,, ...	8	2·1
More than 40 animals	16	4·2
Total ..	*378*	*100·0*

About half the total number of keepers maintain at the most a dozen cattle, including calves ; one-fourth of them have 13 to 24, and less than a quarter possess more than two dozen head. Under these conditions it is not surprising to find that out of 378 families only 37 employed a servant to help them in their work.

It is also worthy of note that the number of cattle tends to increase with the size of the keeper's family as is shown by the following figures :—

Number of persons in family.	*Average number of milch cattle owned per family.*
One ..	8·8
Two ..	11·3
Three ..	12·3
Four ..	10·9
Five ..	13·3
Six ..	16·6
Seven ..	21·0
Eight ..	21·4
More than eight ..	19·8
All families (5·24 persons) ..	*17·6*

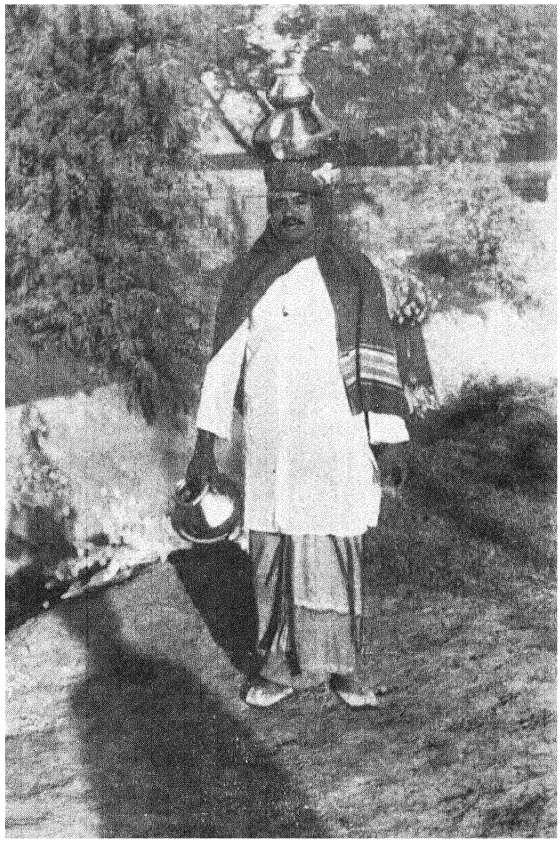


Fig. 6. A Typical Gujar.
(The *gujar* is proud of his profession.)

Fig. 7. The Gujars.

(The milch cattle keepers are illiterate and highly conservative, and keep to their age-long traditions.)

From inquiries made among *gujars* it appears that their economic condition is anything but prosperous and a large number of them are hanging on to their time-honoured profession partly because their wants are few and partly because they know of nothing else to do. It is impossible to fix meticulously the size of an "economic herd," by which is meant that number of milch cattle which allows a chance of profit sufficient to support a *gujar* and his family in reasonable comfort after paying his necessary expenses.* So, while fixing the size of such a herd, both the 'profits of the trade' and the 'reasonable standard of comfort' should be judiciously balanced. Generally speaking, in view of the present condition of milch cattle, the market rates for milk and the standard of living of the *gujar*, it would require at least eight cattle in milk to support a *gujar's* family in Lahore. It has already been observed that the animals in milk form 44 per cent. of the total stock. Hence, we may place the size of an 'economic herd' in Lahore at about 20 head of cattle.

If the above assumption is approximately correct then it is clear that only about one-third of the number of *gujars'* families own 'economic herds,' and the remainder have to supplement their incomes from other sources, or by borrowing. The women and girls in the *gujar* families prepare dung-cakes regularly for sale, which bring them from Rs. 5/- to Rs. 8/- per month. When the number of cattle owned by a *gujar* is small, he usually supplements his income by taking out privately-owned cattle to graze along with his own animals, for which service he charges Re. 1/- per cow, Rs. 2/- per buffalo and Rs. 0/8/0 per heifer per month; the young calves remain at home throughout the day. For milking other people's animals twice a day, morning and evening, he receives Re. 1/- extra per animal per month. These are a *gujar's* honest means of increasing his income. Figures regarding adulteration of his milk have already been referred to in a previous chapter and the income from this source must be fairly substantial.

Indebtedness among gujars.—It has just been said that the *gujar's* condition is anything but prosperous. Intensive inquiries were made into 69 families of the professional milch cattle keepers (*gujars, gowalas,* etc.), and out of these only nine were found to be completely free from debt. The rest were in debt to the following extent :—

Debt.	*Families.*	*Per cent.*
Below Rs. 1,000	30	43·5
Between ,, 1,000 to 2,000 ..	15	21·8
,, 2,000 to 3,000 ..	7	10·1
,, 3,000 to 4,000 ..	3	4·3
,, 4,000 to 5,000 ..	3	4·3
,, 5,000 to 6,000 ..	1	1·4
Above ,, 6,000	1	1·4
Total	*60*	*88·8*

Note.—Money taken as an advance from the *halwais* is not included.

*This is a slightly modified version of the definition of 'economic holding' given by Mr. Keatinge and quoted by Mr. Calvert in his 'Wealth and Welfare of the Punjab,' p. 8.

It will be generally agreed that 'the intensity of debt depends more upon prosperity than poverty.' The capacity of a *gujar* to borrow depends upon his ability to repay the money borrowed, which, in his case, depends mainly upon the number of animals in his herd, the value of ornaments possessed by his womenfolk and his immovable property. It was found in practically every case that when the amount of debt rose to more than Rs. 2,000/-, it was backed by security either in the form of ornaments or building. The rate of interest varied from one per cent. per month to Rs. 1/9/0 per month (*paisa rupia*); when first class security is available in immovable property and ornaments, money can be had against such at Re. 1/- to Rs. 1/9/0 per month. Loans against cattle are generally given at about 2 per cent. per month. The personal security of a *gujar* is more often than not a broken reed, and he has to pay exorbitant rates of interest when he has no tangible form of security to offer.

The *gujar*, however, has no interest to pay for about 20 per cent. of his loans. This amount represents the unpaid price of the concentrates bought by him from the *lahri* (a merchant who deals in provisions for cattle only). The *lahri*, in fact, makes more money by showing this seeming courtesy than he would have done had he charged interest at the usual rate. Thus, when a *gujar* pays in cash, he receives 11 seers of *suri* (ground gram) per rupee, but when he buys on credit he is given only 10 seers, and that all too often of an inferior quality. However, if a *gujar* cannot clear his account within three months of the date of purchase he has to pay interest to the *lahri*.

As to the causes which induce a *gujar* to borrow, 26 per cent. of the total debts were incurred to buy the daily feed for the cattle, 34 per cent. for new milch cattle, 18 per cent. for ceremonies, such as marriages, deaths, *sunnat* (circumcision), 9 per cent. to buy land or construct buildings and cattle sheds, and 13 per cent. for miscellaneous needs.

The most important reason for the chronic state of indebtedness of the *gujar* is the periodic outbreak of epidemics among cattle. The loss of cattle during epidemics is most disastrous and leaves the *gujar* in a very serious position. Another heavy expense which is not peculiar to this class is the expenditure on ceremonies. The average expenses on the marriage of a son are Rs. 400/- and of a girl, Rs. 800/-, which, considering the poor financial resources of the *gujars*, are very heavy. The margin between the daily income and expenditure of a *gujar* is very narrow and if on any day the income falls, or some unexpected expense arises, he has to borrow. In

most cases this chronic state of indebtedness affects him adversely—and he will not aspire to earn more than his daily meagre requirements, believing that—

روگی دا کھا دا تے قرضی دا کھٹیا کسے کم نہیں آؤندا

" Bread to a sick person gives little nourishment, and the profits of the debtor are of no use to him."

2.—The Halwais.

As compared with the professional milch cattle keepers the *halwai* is a middleman pure and simple ; he neither maintains milch cattle nor arranges for the transport of milk: his work begins when the milk has reached his shop and ends when he has retailed it to his customers.

As generally understood the word '*halwai*' means confectioner and milk and curd vendor. But in this report the term has been used only for those persons who sell milk and milk products exclusively or conjointly with sweetmeats and those who deal in sweetmeats alone have been excluded.

A survey of the *halwais* of Lahore made during the course of the inquiry (see Form IV., Appendix D.), revealed the presence of 492 shops, distributed according to communities as follows :—

	Number of shops.
Hindus	208
Mohammedans	268
Sikhs	16
Total ..	*492*

The *halwais* receive their supply of milk twice a day ; three-fourths of the total is received in the morning and one-fourth in the evening. Most of the imported milk arrives before noon ; the evening supply comes chiefly from the city *gujars*. The total quantity of milk handled by them daily was about 489·25 maunds or approximately one maund per shop per day.

Organisation of the milk industry.—The milk market, as has already been stated, is marked by diversity rather than by uniformity. The personal element is prominent leading to great differences in milk prices, rates of advance-money and methods of making good the losses due to breaches in contracts, etc. Some methods of purchase of milk are described below.

(1). *Bandh.*—In order to ensure the receipt of a regular daily supply of milk, the *halwais* enter into contracts with the *gujars* for a uniform supply for a specified period. As a rule, rates are fixed for the whole year, and it has become customary to renew the contracts in the first week of *Maghar* (about the third week of November). Generally, both the maximum and the minimum quantities of milk to be delivered are specified, *e.g.*, between 2 and 2½ maunds per day. In return for this promise of the *gujar*, the *halwai* advances him a sum of money. Such contracts are technically known in the vernacular as '*bandh.*' The advances vary from Rs. 100/- to Rs. 350/- per *pacca* maund of milk to be supplied every day throughout the year. Cases were noted where advances had been given upto Rs. 650/- per *pacca* maund, but only when the honesty of the *gujar* to supply undiluted milk, and his capacity to repay the amount advanced had been well established. On the days when the *gujar* fails to supply the stipulated quantity of milk, the *halwai* debits to the latter's account the difference between the market price of that much milk and the price he would have paid had he received the milk.

No interest is charged by the *halwai* on the money advanced to *gujars*. It is usually realised daily from the price of milk supplied by the *gujar* at the rate of eight annas per day per hundred rupees advanced; *i.e.*, ½ per cent. of the money advanced is repaid every day.

Such contracts, however, are now gradually falling into disuse; the *halwai* does not favour them since he stands to lose, as his advances to a *gujar* are seldom completely realised by the end of the year. Out of 83 cases of *bandh* recorded, only 9 were settled in full and started anew; the remaining 74 still lingered on because of incomplete realisation. In actual practice with such contracts the *halwais* have to meet a further difficulty, due to the low business morality of the *gujars*. Having pocketed the advance money the *gujar* often thinks light of his obligations considering that he has the upper hand. This attitude often defeats the underlying object of the contract and more often than not degenerates into the *gujar* supplying milk of inferior quality—a state of affairs which could not have arisen if the *halwai* had paid cash daily for his supply, and could without loss have declined to take watered milk. As things are, if the *halwai* refuses to take the milk brought by the *gujar*, he has no other alternative but recourse to law to realise his advance, and this would involve much trouble and expense. To avoid this trouble he is forced to accept milk of inferior quality.

(2). *Khulla wihar.*—For the reasons referred to above, the alternative practice called '*khulla wihar*' (open business) is gaining in popularity. The essence of this practice is that both parties are free to buy milk from, or sell to, whomsoever they choose.

Nothing is given in advance, and the *gujar* receives payment for milk the next day after it has been supplied to the *halwai*. Prices vary according to market conditions and in case either of the parties is dissatisfied with the quality or price, a few days notice is all that needs be given and in the meantime new arrangements can be made. Theoretically, both parties are at liberty to cry 'halt' at any time they like, yet, the same set of buyers and suppliers often continue to work together for months.

The above practice has given rise to another set of milk dealers, who may be termed 'middlemen *halwais*.' Their business is to buy from such *gujars* as have no contract with any *halwai*, and to resell the milk to other *halwais* at a small profit. There are four such shops of middlemen *halwais* in Lahore and the appearance of this class marks an advance upon the system of '*bandh*' and seems to be the first step towards co-operative marketing of milk. The method, however, is not free from abuse. In the case of two of these middlemen it was found that they had arranged with a local dairy to have some of their milk skimmed. The cream was bought by the dairy at the rate of 14 annas or Re. 1/- per seer and the separated milk was mixed with the rest of the whole milk, roughly in the ratio of 1 to 4, and sent on to small *halwais* as pure milk.

(3). Side by side with these two systems there is yet another followed by some *halwais*. In this case no advance is made in cash, but the value is given in kind. The *halwai*, for example, buys milch cattle for the *gujar*; the selection of the animals is left entirely to the *gujar* who feeds and looks after them. Every drop of milk yielded by these animals is to be handed over to the *halwai*, who pays a portion of its price at a stipulated rate to the *gujar*; the rest of the price is credited to the *gujar's* account. When his debt has been paid off, the ownership of the animals passes to the *gujar*, but should any of the cattle die during this period, he has to make good the loss.

Payments.—Out of 470 *halwais* from whom information was gathered, 432 made daily payments for the milk purchased, one made weekly payments, 10 fortnightly and 27 monthly.

Daily turnover of halwais.—It has been mentioned before that the 492 shops of *halwais* deal with about 489·25 maunds of milk per day; the following table classifies this turnover according to the kind of milk and the time of its receipt :—

Table showing Milk received Daily by Halwais.

	Milk received daily by the halwais.				
	Cow's.	Buffalo.	Goat's.	Total.	Average for 492 shops.
	Mds.	Mds.	Mds.	Mds.	Mds.
Morning ..	94·50	270·25	3·25	368·50	0·75
Evening ..	50·75	68·25	1·50	120·75	0·24
Total ..	*145·25*	*338·50*	*4·75*	*489·25*	*0·99*

The milk received by *halwais* is retailed in the form of fresh and heated milk, curd and *khoya* (desiccated milk). Fresh, unheated milk is stored in brass vessels (*valtohis*) similar to those used in its transport; heated milk is kept at a constant high temperature in *karahis* (broad iron pans). In the present conditions of gross neglect of sanitary requirements, this method is commendable, because no bacteria can live at the high temperature at which milk is kept until the last drop in the pan has been sold off. In order to prepare curd, the milk is boiled for some time and then allowed to cool; while still lukewarm it is laid out in broad, shallow, earthenware basins and a little 'starter,' *i.e.*, the previous day's curd beaten up, added. Curd is ready for use six to eight hours after the 'starter' has been added to the milk. *Khoya* is prepared by keeping milk continuously stirred at boiling temperature, until most of the water in it has evaporated and only a thick paste left. For preparing curd and *khoya* buffalo milk is invariably used, because of the high percentage of total solids present in it.

The respective quantities of milk in the popular forms in which it is sold by the *halwais*, cannot be given accurately, but an approximate estimate is as follows :—

	Maunds.
Fresh milk	90
Heated milk	210
Curd	150
Khoya	50

Out of the 419 *halwais* for whom complete information was collected, only 252 were found to be buying both cow's and buffalo milk; the rest purchased buffalo milk only, yet it is amusing to note that no *halwai* refuses a request for cow's milk: a portion of the buffalo milk, soon after it reaches their shops, is readily transformed into "cow's milk" by diluting it heavily with water.

Wholesale rates of milk.—The following table shows the rates of purchasing cow's and buffalo milk along with the number of *halwais* buying at the given rates :—

Table showing Rates of Purchase of Milk by Halwais.

Rate per *pacca* maund (100 lb.)		No. of halwais buying at this rate.	
		Cow's milk.	Buffalo milk.
Rupees.	Annas		
6	0	1	..
6	8	4	..
6	12	9	..
7	0	16	..
7	4	16	..
7	8	17	7
7	12	10	10
8	0	62	24
8	4	6	14
8	8	24	28
8	12	10	22
9	0	68	131
9	4	3	31
9	8	3	29
9	12	1	113
10	0	2	4
10	4	..	2
10	8	..	4

It will be seen that two-thirds of the *halwais* buy cow's milk between Rs. 8/- and Rs. 9/- per *pacca* maund, and three-fourths of them buffalo milk at between Rs. 9/- and Rs. 10/-. Therefore, roughly speaking, Rs. 8/8/0 and Rs. 9/8/0 per *pacca* maund may be taken to be the average rates for cow's and buffalo milk, respectively. The considerations which a *halwai* has in mind when fixing the price of milk seem to be :—

(*a*). Whether the rate is to be fixed for the whole year or for a shorter period. When fixing the rate for the whole year, both dull and brisk seasons have to be considered, whereas for short periods the conditions expected to prevail in the near future are the only considerations.

(*b*). The *halwais* like to receive the first instalment of milk by dawn and the later the hour of delivery of the milk, the lower is the rate offered by them. Some investigators have attempted to correlate the rates with

the distances of transport, showing that the farther a village the lower the rates offered. The real cause in Lahore would seem to be, not the distance, but rather the lateness of the hour at which milk from the more distant villages reaches the town. People who bring milk early to a *halwai's* shop from a village 20 miles away secure a better price than those who arrive at 8 or 9 in the morning, even though the latter come from nearer villages.

Realisation of bad debts.—The *halwai* is not merely the customer of the *gujar* but also his financier and when he finds that the latter's indebtedness has surpassed his ability to repay, instead of going to the court for the realisation of the debt, he offers the *gujar* a slightly higher rate for his milk, perhaps realizing that " it is better to put up with a trifling loss than to run the risk of losing all by going to law."

Retail rates of milk.—The following table shows the rates at which the *halwais* sell milk and curd to their customers :—

Table showing Retail Rates of Milk and Curd.

Rate of sale per seer.	Number of halwais who sell at this rate.			
	Fresh Cow's milk.	Fresh Buffalo milk.	Heated milk.	Curd.
Rs. a. p.				
0 2 6	1	..	..	..
0 3 0	74	12	1	2
0 3 3	16	1	..	..
0 3 6	193	62	..	..
0 3 9	..	3	1	..
0 4 0	82	311	234	138
0 4 3	..	..	..	1
0 4 6	1	6	19	12
0 5 0	..	..	133	305
0 6 0	..	..	1	12
Total ..	*367*	*395*	*389*	*460*

We may take the rate of sale of fresh cow's milk to be Rs. 0/3/6 per seer, and for fresh buffalo milk Rs. 0/4/0 per seer. There are two rates for heated milk, Rs. 0/4/0 and 0/5/0 per seer. Curd may be had at Rs. 0/5/0 per seer.

Gross profits of the halwai.—The difference between the purchase and sale prices may be taken to be the gross profits of the *halwai* and an estimate of these profits per *pacca* maund is given below :—

An Estimate of Gross Profits of Halwais per Pacca Maund.

	Cow's milk.	Buffalo milk.	Heated milk.*	Curd.*
	Rs. As.	Rs. As.	Rs. As.	Rs. As.
Amount received by the *halwai* by sale ..	10 15	12 8	11 4 to 14 1	14 1
Amount paid by the *halwai* at purchase ..	8 8	9 8	8 8 to 9 8	9 8
Halwai's gross profits ..	*2 7*	*3 0*	*2 12 to 4 9*	*4 9*

These figures do not take into account the profits a *halwai* makes by fraudulent methods, which may be all or any of the following :—

(*a*). Getting some of the milk skimmed. (This is usually done only by the wholesale dealers.)

(*b*). Adding water to milk and selling highly adulterated buffalo milk as cow's milk.

(*c*). Removing the layer of *malai* that comes to the top of milk when gradually heated ; it may be sold separately or churned to extract butter.

Rough as these estimates of gross profits are, they show that even after deducting his business expenses, the *halwai* makes large profits on the capital he invests in the business.

3.—Dairies.

Gujars are indigenous dairymen who for generations have been keeping milch cattle for the production of milk for sale. The so-called 'dairies' are however run by 'outsiders' on purely commercial lines ; hence their separate mention.

During the inquiry, 18 dairies (excluding the *gowshala*) were visited in the Lahore Municipal area and this is believed to be their total number.

*Fresh milk when heated or converted into curd loses about 10 per cent. of its weight on account of evaporation. Therefore, only 45 seers of heated milk and curd are shown as against 50 seers of milk purchased by the *halwai*.

Two of the proprietors declined to give any information about their affairs; hence the information given in this section refers to the remaining 16 dairies.*

The appearance of dairies is a recent feature in the milk trade of Lahore. Ten of the dairies did not exist prior to 1927; four trace their origin to the period between 1912 and 1925, and only one dates back to 1895. Information on this point regarding the Lahore Cantonment Military Dairy could not be procured, and in any case, it is situated outside the Lahore Municipal area.

Total milk supply of dairies.—The total daily supply from all 16 dairies amounts to 52 maunds of milk, 475 lbs. of butter and 71 lbs. of cream. Three dairies supply milk only, five butter and cream only, while eight supply milk, butter and cream.

Sphere of operation of dairies.—The regular customers of the dairies (excluding those of the Lahore Cantonment Military Dairy) are 821 families, 10 hotels and 5 confectioners.

Rates charged by dairies.—The rates charged by the dairies vary: three sell milk at 2½ annas per lb., one at 4½ annas per seer, three at 4 annas per seer and five at 5 seers per rupee.

As a rule, the dairies do not charge different prices for cow's and buffalo milk; only a few of them sell pure milk. 'Standard milk' is their slogan by which they mean the milk which conforms to the standards laid down in 1925 by the Chemical Examiner to the Punjab Government. These standards are as follows:—

Standards for Milk as laid down by Punjab Government.

Animal.	Milk Standards in the Punjab.	
	Percentage of milk fat (lowest limit).	Percentage of non-fatty solids in milk (lowest limit).
Cow .. .	3·5	8·0
Buffalo .. .	5·0	9·0
Mixed milk (cow and buffalo) .	3·5	Lactose (lowest limit) 4·0

Analytical tests revealed that the milk supplied by the dairies was in no way chemically superior to the milk supplied by the *gujars*. As to its

*For a schedule of questions according to which information was collected from the dairies, reference may be made to Form III., Appendix D.

biological condition there was only one dairy equipped with a pasteurizing plant.

The usual rate charged for butter is Rs. 1/4/0 per lb. retail, and Re. 1/- per lb. wholesale. The maximum rate charged is Rs. 1/12/0 per lb., and that by only one dairy. Cream sells 4 annas per lb. cheaper than butter.

Dairies not necessarily milk producers.—It would be erroneous to say that dairies in Lahore are milk-producing units; only five out of the sixteen dairies have their own herds, two rely more or less on the local *gujars* for their supply, while six others purchase the whole of their supplies and act purely as distributors; three dairies are branch offices, receiving their supply from their head offices situated elsewhere.

Live-stock kept by dairies.—Only eight dairies keep cattle, the number being as follows :—

		Cows.	*Buffaloes.*
Cows (total)	..	402	306
Cows (in milk)	..	259	221
Calves	..	135	50
Bulls	..	8	5

The foregoing figures disclose two things: first, 65 per cent. of cows and 72 per cent. of buffaloes are in milk; second, the small number of calves especially in the case of buffaloes, a feature already dealt with elsewhere in this report.

Only three out of eight dairies maintaining milch-cattle, keep breeding-bulls. The Lahore Cantonment Military Dairy Farm, it may be mentioned to its credit, has laboured at improving its stock by judicious cross-breeding. It has in its herd 5 bulls, 3 of which are pure Friesians and 2 of the *Sahiwal* breed. The bulls of the other 2 dairies are of pure Indian breeds and seem to have been wisely selected.

Feed expenses.—It may be said in a general way that the cost of feed per animal is higher in the smaller than in larger dairies and that the volume of business and expense decide profit or loss. The expense of operating a 200-seer dairy is not 20 times as great as the expense of operating a 10-seer dairy. The division of expenses among 200 seers makes each seer carry a much smaller tax than where expenses are divided among 10 seers. The estimated daily cost of maintaining a cow ranges between Rs. 0/7/8 to Rs. 0/12/0 and that for a buffalo between Rs. 0/10/0 to Rs. 0/14/0. Only three dairies, however, have land for growing their own fodder; the rest have to purchase it.

Distribution pays better than production.—With some dairies it is a matter of policy to purchase a portion of their milk requirements with a view to keep their own supply elastic. Others, however, find it more remunerative to act as distributors than to produce milk from their own herds. To give a concrete case, one dairy 'A' sells 75 seers of milk daily at four annas per seer and no other dairy produce. The whole of the milk is produced on the farm by one cow and 11 buffaloes. The daily cost of feed, according to the actual figures given by the managing-proprietor of this dairy, is 7 annas per cow, 14 annas per buffalo, one anna per calf and 14 annas for the breeding bull. This works out at 2 annas 5 pies per seer of milk produced; other expenses have to be added, *e.g.*, housing, milking, interest on capital, and casual loss through disease and deaths. According to the estimate of the manager these amount to another 8 pies per seer, which gives a total cost of production of 3 annas 1 pie per seer of milk.

In contrast to 'A' another dairy 'B' purchases its total supply from the *gujars* at Rs. 9/- per maund of 50 seers, and sells it at the same rate as 'A.' Its supply price of milk is 2 annas 10½ pies per seer, *i.e.*, 2½ pies lower than in the case of the dairy 'A'—by no means a negligible difference.

The reason for the low cost of production of milk to a *gujar* is not far to seek. He does all the labour himself whereas a dairy proprietor is more or less an entrepreneur. The requirements of life for the *gujar* are very limited and can easily be fulfilled if his business leaves him with even one rupee a day. This is a much lower standard than that of the dairy owner. Lastly, by the accumulated experience of generations the *gujar* has so well imbibed the art of dairying and cheap feeding of cattle that he can easily outstrip the dairy in the production of cheap milk.

Butter.—Next to milk, butter is the chief product of the dairies. They do not produce it directly from milk or milk-curd, which is the accepted Indian method, but from cream in the following way: contracts are made by the dairy owner with the *gujars*, who bring milk from outside, to have a stipulated quantity of milk skimmed in the dairy every day, the milk being returned to the owner after skimming. Some dairies purchase the cream according to weight, others make payment on its butter outturn. In the former case the price is Re. 1/- to Rs. 1/4/0 per seer; in the latter 12 to 14 annas per pound of butter obtained. It requires 1¼ lbs. to 1½ lbs. of cream to produce 1 lb. of butter: so the amount received by the *gujars* is practically the same in either case.

CHAPTER VI.

MILCH CATTLE AND THEIR FEEDING.

The cattle census, taken in January, 1930, by the Director of Land Records, Punjab, gives the following figures for milch cattle in the Lahore Municipal area :—

		Number.
(*i*).	Bulls	163
(*ii*).	Cows	4,822
(*iii*).	Young stock of cows	3,710
(*iv*).	Buffaloes	2,275
(*v*).	Young stock of buffaloes ..	2,368
	Total ..	*13,338*

NOTE.—Young stock are calves up to 3 years of age.

Some further details of the milch cattle as given in the Cattle Census Report for 1930, are as follows :—

A. Cows—		*Number.*	*Percentage.*
(*i*).	*Bulls (by breeds)*—		
	Hissar (Hariana)	92	..
	Montgomery	19	..
	Dhanni	7	..
	Dajal	7	..
	Others (non-descript) ..	38	..
	Total ..	*163*	..
(*ii*).	*Cows*—		
	(*a*). Capable of giving milk ..	3,798	79
	Others* ..	1,024	21
	Total ..	*4,822*	*100*
	(*b*). Born in Lahore district ..	2,343	49
	Others	2,479	51
	Total ..	*4,822*	*100*
(*iii*).	*Young stock*—		
	Males	1,570	..
	Females	2,140	..
	Total ..	*3,710*	..

*Cattle which are too old or sterile or otherwise incapable of giving milk.

B. Buffaloes—

(*i*). *Bulls*—Figures regarding bulls are not given separately. The number of male buffaloes is given as 347, of which 296 are shown as 'capable of draught' and the remaining 51 as 'others.'

(*ii*). *Buffaloes*—		*Number.*	*Percentage.*
(*a*).	Capable of giving milk ..	1,813	80
	Others (too old or sterile) ..	462	20
	Total ..	*2,275*	*100*
(*b*).	Born in Lahore district ..	1,037	46
	Others	1,238	54
	Total ..	*2,275*	*100*
(*iii*). *Young stock*—			
	Males	1,441	..
	Females	927	..
	Total ..	*2,368*	..

429 out of 1,570 male calves below three years, and 761 out of 1,141 male buffalo calves are specified as 'castrated.'

The Cattle Census Report gives no information regarding the number of cows and buffaloes in milk, the number of suckling calves, and the number of milch cattle owned by professional men and those kept privately. In view of this, another cattle census was taken in May, 1930, with the help of the staff of the local Municipal Health Department—(*see* Appendix D.; the questionnaire used was in vernacular)—and the following figures were collected regarding the cattle of professional keepers :—

Cows—	*Number.*	*Percentage.*	*Total.*
Bulls		..	73
Cows, in milk	1,957	62	
,, , dry	1,162	38	3,119
Calves below one year ..	1,498	..	
,, above ,, ,, ..	445	..	1,943
Buffaloes—			
Bulls		..	16
Buffaloes, in milk ..	772	66	
,, , dry	402	34	1,174
Calves, below one year ..	257	..	
,, above ,, ,, ..	63	..	320
Total ..		..	*6,645*

The district of Lahore is not a prominent cattle breeding area, as is borne out by the figures just quoted, *viz.*, 51 per cent. of the cows and 54 per cent. of the buffaloes in the city were not born in the district. A study of the movements of milch cattle in the Punjab indicates that from the Hariana tract in the south-east and the districts of Montgomery and Multan in the south-west, good milch cattle are constantly imported into the central parts of the Province, while simultaneously there is a corresponding movement in the clearance of superfluous and worn-out stock towards the North-West Frontier, owing to the great demand for beef in that region. A considerable number of old, sterile or otherwise useless stock is sent to the local slaughter-house. The following table shows the number of cattle slaughtered in Lahore from 1914 to 1929 :—

*Number of Bovine Animals Slaughtered in Lahore from 1914 to 1929.**

Year.	Cows.	Buffaloes.	Total.
1914	7,851	4,259	12,110
1915	6,935	3,833	10,768
1916	8,022	3,026	11,048
1917	5,591	5,754	11,345
1918	6,465	5,543	12,008
1919	9,505	4,306	13,811
1920	7,852	4,654	12,606
1921	6,534	6,138	12,672
1922	7,754	4,923	12,677
1923	6,939	4,361	11,300
1924	7,328	4,457	11,785
1925	7,802	4,813	12,615
1926	6,656	6,125	12,781
1927	7,599	6,299	13,898
1928	8,492	6,101	14,593
1929	6,473	7,100	13,573

*The figures were obtained partly from the Annual Reports of the Municipal Committee, Public Health Department, and partly from the records of the Veterinary Assistant in charge of the local beef slaughter house.

Breeds of cattle.—In Lahore most of the cattle are of a non-descript breed. Nevertheless, there are to be found scattered here and there a small number of pure-bred animals. Among the cows, the *Sahiwal* or *Montgomery* breed is undoubtedly the best. The breed is locally known by different names, *e.g.*, *Lambi*, *Ganji* and *Sandal*, after their habitat, the three chief *bars* in the south-west of the Province before the introduction of canals ; also *dhunni wali gau* and *lola*, because of its prominent and well-developed navel. This breed has been described as " small, shapely and short-legged with a fine clean cut head, short horns, small alert ears, thin neck, fine leg bones, small feet, and exceptionally long and thin tail."* The skin of a *Sahiwal* cow is thin and the hair fine ; the horns are short and set into the head so loosely that they can be shaken at their base; the back is slightly dipped and rises gently towards the croup; the udder is large and capacious with long and well set teats. In general the frame broadens towards the rump and narrows towards the neck; this 'wedge-shaped' appearance is universally recognised as an indication of heavy milkers. The colour of the skin varies a great deal but dark red is much prized. The cows of this breed give from 7 to 12 seers of milk per day.

The most popular breed of buffaloes in the Punjab is the *Kundi* or *Murrah*, so called from the characteristic spiral formation of the horns, which are thick at the base and incline backwards and upwards and then curl up in two or three coils. The buffaloes coming to Lahore from the south-eastern districts are superior to those coming from Montgomery and other parts of western Punjab. The value of the *Murrah* is generally judged by the shape of the horns ; those with the greatest degree of curliness show quality, good breeding and pure blood and as such fetch good prices, whereas those with straighter and more open horns are indicative of mixed blood and are not much liked. A pastoral saying depicts the idea thus—

مجھیں مجھیں ہر کوئی آکھے - مجھیں نہیں کوئی پریاں
سنگ جنہاں دے وَل وَل کُنڈے - دین دُدھاں دیاں گھڑیاں

" The word buffalo is on the lips of everyone. Buffaloes they undoubtedly are, but it would not be too much to call them fairies. Those amongst them that possess spirally curved horns yield several bucketsful of milk."

The *Murrah* breed of buffaloes are the heaviest milkers of all Indian breeds of cattle. The animals are jet black mostly with scanty black hair, but quite a number of brown animals of a very good class and true to type are also found. They possess a square type of body frame,

*Mollison and French in the ' Agricultural Journal of India,' Vol. II., p. 252.

short-legged as compared with most Indian breeds of cattle, and are of massive bulk with a specially thick skin. The neck even in the females is short and heavy and the head well set at that particular angle which denotes the water-loving instincts of the animal. The forehead is broad with eyes small and active. The female buffaloes weigh from 800 to 1,600 lbs. The so-called *panch-kalliani* (five best points) buffaloes are liked best, and are characterized by white forehead and white socks on all four limbs rising above the fetlocks. On the whole the animals are very highly domesticated, quite docile and easily handled, although some of them are very obstinate and exhibit a peculiar nervousness amounting almost to fright when people other than their regular attendants approach them.*

The *Murrah*, like other buffaloes, does well on coarse fodder as compared with cows, and their capacity for converting feed into milk is probably unequalled by any class of animal in India. The quality of milk is also equal to that of any other heavy milking strain of Indian buffaloes, the fat percentage on the average being 6·73. The table on the next page gives the chemical analyses of the milk of 21 buffaloes in Lahore.

Deterioration of cattle.—There is a common complaint that the Punjab cattle have deteriorated during recent years. Mr. William Smith, the Imperial Dairy Expert to the Government of India, in his evidence before the Royal Commission on Agriculture in 1926 stated, "Since I came here (21 years ago) I certainly think the quality of cattle has deteriorated... I have bought cattle in the Punjab since 1906 up to a year or two ago, and every year, believe me, the cattle at the Amritsar fair are getting worse and worse... Mr. Keventer says exactly the same thing that the quality of the animal he can now get to-day is nothing like so good as the quality of those he got 25 years ago."†

A steady diminution of the pasture land in favour of arable farming, consequent upon the increase in the human population is a factor that has decidedly influenced the deterioration in the quality of cattle. With the opening of the Canal Colonies the professional and the hereditary graziers of Sahiwal, who used to keep large herds of pure-bred *Montgomery* cows of excellent milking strain, have been displaced almost to the point of extinction by the enormous influx of wealthier *zemindars* from the central Punjab. The latter brought with them their own breeds of cattle. This resulted in promiscuous breeding which has proved detrimental to the pure *Sahiwal*, the breed which stands out pre-eminent, and perhaps without a rival, for milk production in the whole of India.

**Vide.* "Journal of the Central Bureau for Animal Husbandry and Dairying," Vol. I., Part IV., January 1928, p. 153.

†*Ibid.* Evidence Vol. I., Part II., pages 29-30.

Table showing the Chemical Analyses of Milk of 21 Buffaloes in Lahore.

No. M.=Morning. E.=Evening.	Specific gravity.	Water.	Fat.	Sugar.	Proteins.	Ash.	Total solids.	Solids-not-fat.
1. ..	1·0320	82·25	6·41	..	..	0·945	17·75	11·34
2. ..	1·0330	82·14	5·50	..	..	0·820	17·85	12·35
3. ..	1·0306	80·91	8·80	4·200	4·66	1·040	19·09	10·29
4. ..	1·0259	80·38	9·60	4·740	3·85	0·750	19·62	10·02
5.	1·0322	83·78	5·90	5·440	4·54	1·010	16·22	10·32
6. ..	1·0292	79·18	9·80	4·956	4·59	1·120	20·82	10·92
7. ..	1·0260	83·28	7·50	4·232	4·01	0·800	16·72	9·22
8. ..	1·0297	83·14	6·90	4·956	3·84	0·700	16·56	9·66
Average of 8 samples ..	*1·0298*	*81·88*	*7·55*	*4·754*	*4·25*	*0·898*	*18·08*	*10·515*
9. M. ..	1·0282	81·44	9·20	4·60	4·00	0·760	18·56	9·36
E. ..	1·0290	82·00	8·30	4·80	4·16	0·740	18·00	9·70
10. M. ..	1·0310	76·48	12·20	4·62	5·78	0·920	23·52	11·32
E. ..	1·0302	78·64	12·20	4·50	3·74	0·920	21·36	9·16
11. M. ..	1·0300	82·80	7·40	4·46	4·44	0·900	17·20	9·80
12. E. ..	1·0338	87·80	4·40	4·64	3·46	0·700	13·20	8·80
13. M. ..	1·0338	83·30	7·20	4·64	4·00	0·860	16·70	9·50
14. M. ..	1·0356	85·80	4·90	5·75	2·85	0·700	14·20	9·30
E. ..	1·0356	85·50	4·90	5·71	2·89	0·700	14·50	9·30
15. M. ..	1·0358	83·86	5·30	5·70	4·34	0·800	16·14	10·84
E. ..	1·0386	83·80	4·90	5·75	4·70	0·850	16·20	11·30
16. M. ..	1·0366	82·60	7·20	5·35	3·87	0·920	17·34	10·14
E. ..	1·0340	82·70	7·20	5·56	3·64	0·900	17·30	10·10
17. M. ..	1·0370	83·62	6·10	4·70	4·70	0·880	16·38	10·28
E. ..	1·0360	82·30	7·10	4·85	4·85	0·920	17·70	10·60
18. M. ..	1·0356	83·80	5·30	6·09	4·01	0·800	16·20	10·90
E. ..	1·0346	81·80	6·70	6·09	4·61	0·800	18·20	11·50
19. M. ..	1·0316	83·20	7·10	5·52	3·38	0·800	16·80	9·70
E. ..	1·0356	82·40	7·60	5·47	3·57	0·960	17·60	10·00
20. M. ..	1·0370	85·40	3·90	5·33	4·55	0·820	14·60	10·70
E. ..	1·0350	84·64	4·30	5·36	4·84	0·860	15·36	11·06
21. M. ..	1·0352	85·68	5·20	5·42	2·86	0·840	14·32	9·12
E. ..	1·0342	84·56	5·40	5·38	3·86	0·800	15·44	10·04
Average of 23 samples ..	*1·0340*	*83·22*	*6·69*	*5·23*	*4·05*	*0·832*	*16·82*	*10·19*
Average of 31 samples ..	*1·0319*	*82·55*	*7·12*	*4·992*	*4·15*	*0·865*	*17·45*	*10·35*

NOTE 1.—First 8 analyses were carried out by Prof. Aggarwala and Mr. J. R. Sethi in 1925 and referred to pure buffalo milk obtained from animals in Lahore. Fat was determined by the Leffmann-Beam method, Sugar by Soxhlet's method, and Proteins by Kjeldahl-Gunning-Arnold method.

NOTE 2.—The last 23 analyses were carried out by Prof. Aggarwala and Mr. Abdul Wahid Khan during the course of the present inquiry. Fat was determined by Gerber's method, Sugar by the Soxhlet's method and Proteins by simple elimination.

Further, some of the best types of milch cattle are exported every year from the Province in large numbers to other parts of India. This fact has told rather severely on the existing breeds left behind. "Both Rangoon and Calcutta depend almost entirely on the Punjab for the supply of their milch animals while Bombay draws its milking cattle from the Punjab and Sindh."* In 1910, Mr. Stow wrote, "The valuable breed of milch cattle in Montgomery is drawn upon to such an extent that it is in danger of extinction."† For the last twenty years or so the exploitation of Punjab cattle has been going on unfettered and its resultant effect has made the position progressively worse year by year.

Furthermere, scientific and systematic breeding of cattle is practically unknown to the people. In fact, they have not been 'breeding' cattle; they have been merely producing them. Quality and discreet selective breeding have been lamentably neglected in favour of production in large numbers of almost useless cattle. As a result of this indiscriminate breeding the deterioration in quality has become more and more apparent. Little care is exercised in the selection of bulls. A good bull forms the keystone in the whole system of cattle breeding. Many well-to-do Hindus, out of religious sentiment, let loose small, ill-bred and good-for-nothing bulls, provided with no adequate arrangement for their upkeep and feeding, for the free and promiscuous service of cows. This practice is manifestly harmful. No arrangements are made for keeping the young male stock separate from the young undeveloped heifers; this tends to produce weak and under-sized progeny. Quite a large number of scrub bulls are left uncastrated. This perpetuates bad strains, and the people, in face of religious sentiments, are reluctant to arrange for the removal of inferior and worn out sires.

The above remarks, however, are not applicable in the case of buffalo bulls. As a rule, they are chosen with great care, are well-fed and properly looked after. For the most part of the day they are kept tethered and their owners usually charge a fee of one or two rupees per service.

It has been stated above that the quality of cattle in the Punjab, as a whole, has been progressively deteriorating. In Lahore, however, because of the comparatively high cost of their feed and maintenance, only those animals, which can economically cover their upkeep and leave a little margin for the owner besides, are retained. The cattle which are

* Mr. William Smith before the Royal Commission on Agriculture. Evidence Vol., I., Part II., page 3.

† 'Cattle and Dairying in the Punjab' by Stow, p. 13.

unprofitable are weeded out and their places filled by the importing of animals of remunerative value.

Lahore is an expensive city in which to keep and rear cattle. Fodder, both green and dry, and other food stuffs for feeding cattle are dearer than anywhere else in the Province. The rent for cattle-yards is high and labour dearer still. In view of these local difficulties it is obvious that young, sterile and otherwise useless cattle are soon sold to butchers or sent to places outside the city. The worst feature of the situation, however, is that once a good animal comes into Lahore, more often than not, it is completely lost, in so far as its progeny is concerned.

The *gujars* as well as private owners are mainly concerned with their own immediate benefit, and partly through lack of foresight or strained financial conditions, they are utterly careless about the rearing of calves. Judging from the figures on p. 78, about 24 per cent. of cows and 67 per cent. of buffaloes of professional cattle keepers, while in milk have no suckling calves. Further, as against 1,498 cow-calves in the first year, there are only 445 in the second; the corresponding figures for buffalo-calves are 257 and 63, respectively. These figures show that a strikingly small number of both cow and buffalo-calves either survive their first year of existence or are kept in Lahore. Female buffalo calves and male calves of cows, however, are better looked after because they fetch higher prices when reared. A common saying thus depicts the importance of such male calves:—

گائیں وچھیاں تائیں

(A cow is prized much when she drops a male calf.)

Again,

بھاگ ہون تیجھے مجھیں دین کٹیاں تے گائیں دین وچھے

(When fortune favours, buffaloes drop female calves and cows male calves.)

There is the further question as to why the number of buffalo-calves surviving is so much less than the number of cow-calves which servive the first year. This is so, because, in the first place, the former can suffer privation more easily than buffalo-calves and can live on very meagre fare. It is a matter of common experience that during the winter season *gujars* generally tether their cows and buffaloes in milk under roof, whereas the calves are left shivering outside in the cold. During

this period mortality amongst the buffalo calves is much heavier than amongst the cow calves. Some *gujars* suggested that buffalo calves are highly susceptible to skin diseases which often prove fatal. The real reason, however, is that buffalo calves are generally neglected as to their feeding and general cleanliness and contract skin diseases and die sooner than cow calves; also that cows love their young more than buffaloes do and when their suckling calves die they often refuse to give milk. A sudden fall in a cow's milk yield is generally associated with the death of her calf. The buffaloes, on the other hand, are hardier and are less grieved at the death of their calves, as the following proverbs show :—

مجھیں تے مچھرانیاں - بھاڑا جنہاں دا مول

'Buffaloes and woman grain parchers concern themselves with the remuneration only.' The implication is that the buffalo, unlike the cow, is not so attached to its calf and can be milked even in its absence.

دھن مینہہ دے جیرے - پُت مراون تے دُودھ پلاون

'Bravo to the buffaloes' courage! They suffer the loss of their sons yet keep on giving milk.'

Feeding of cattle.—A cow or a buffalo may be looked upon as a 'living chemical factory' or a 'transforming machine' that is continuously converting rough, vegetable food materials into products useful to man, such as milk. The cattle of to-day are, to a great extent, products of civilisation in the fabric of which they have become well nigh indispensable. Originally, they were not designed by Nature to produce milk in large quantities. Owing to man's skill in selective breeding, improved methods of feeding and general animal management, the productive capacities of milch animals have developed to such an extent that their milk has now become an important article of human diet. This artificial strain of increased milk production means a drain upon the bodily resources of the animals, which resources, in turn, depend entirely upon the food available to them. The losses sustained by them in milk production must be made good by proper and liberal feeding of well-balanced rations. There is a great deal of truth in the old saying that "Milk goes in at the mouth," and "Hens lay through their beaks."

The problem of the feeding of milch animals is one of great economic importance from the point of view of the agricultural interests of the country, and yet there is no problem about which the cattle keepers, both professional and private, are so ignorant. With the *gujars*, *gowalas* and other

milch cattle keepers, the cost of feeding their animals represents an important item of expenditure. The methods of feeding followed by them are based on tradition rather than scientific experimentation. "For generations past *zemindars* have been feeding their cattle according to the experiences of their forefathers and themselves, and very often their methods have proved to be fairly correct and sound, but at the same time the practice has helped in handing down from father to son, and from generation to generation, mistaken notions and incorrect methods of feeding cattle, so that they have become unchangeable truths and veritable facts. The result is that at present we find prejudices deeply established through constant usage and custom."* To obtain the maximum utility and the best physiological results from a milch animal without impairing her health or breeding capacity it is essential that she be fed on modern scientific lines, combined with practical common sense and constant personal supervision, so that there may be the least amount of waste and a minimum of expenditure. The *gujars* and other cattle keepers are illiterate and highly conservative and do not avail themselves of the results and benefits to be obtained from the adoption of the latest discoveries in methods of animal nutrition; they continue to follow mediaeval methods of feeding and management.

As a rule, the *gujar* does not make any proper discrimination between heavy and poor milkers in his herd; all animals are fed on the same scale or nearly so. Very few are fed in stalls; fields of fodder are bought from *zemindars* and the fodder is cut and thrown to the animals in the fields. Thus the heavy milkers, poor milkers and dry stock are equally well or ill-fed. Dry stock, however, are given no grain or concentrates, the latter of which are soaked in water, left overnight and spread in a common manger from where the cattle are allowed to eat in batches of four or five at a time. Here, the *gujar* does make some rough differentiation, allowing the good cows to eat for a longer time than the others.

The ingredients of the concentrated ration remain the same nearly all the year round. The following is the daily allowance of concentrates fed by a *gujar* to an average cow giving 5 to 6 seers of milk.

	lbs.
Wand (coarsely ground gram)	4
Phhak (rice husk)	6
Chhillar (gram husk)	1¼

* 'Feeding and Milking of Cows,' by A. C. Aggarwala.

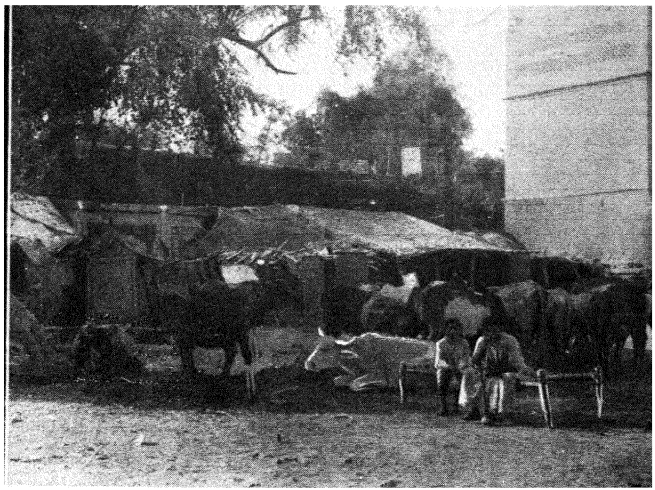


Fig. 8. A Typical House of a Gujar.

(A characteristic feature of the Indian dairy industry is the large number of cattle kept within the city boundaries ; the cleanliness and the general health of the city is thus greatly endangered.)

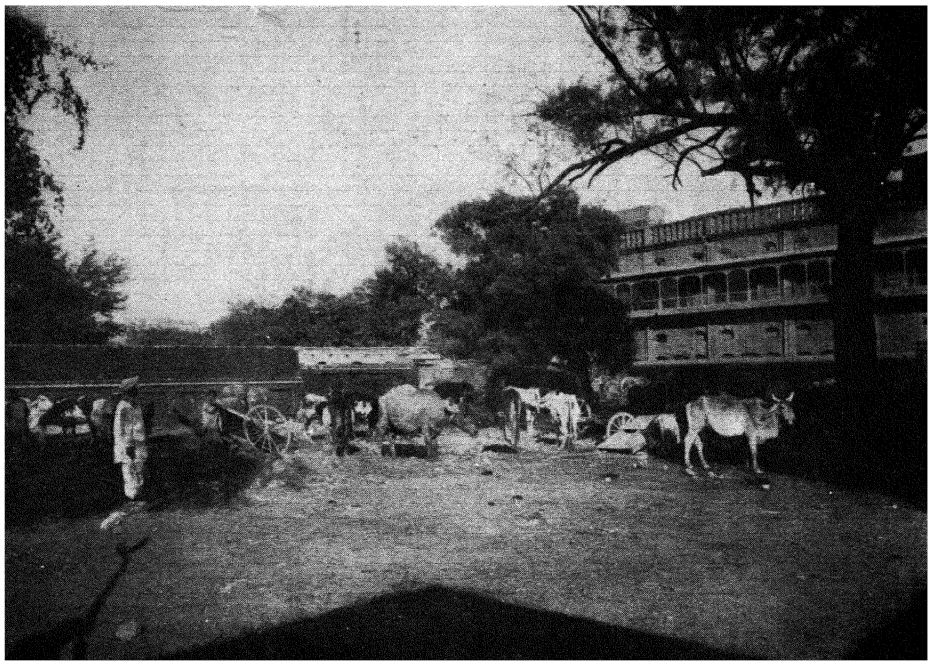


Fig. 9. Typical Gujar Premises.

(The *gujar* premises are often an indescribable litter of animals, vehicles, pots, pans, fodder, human beings, rubbish and debris from surrounding residences.)

The privately owned cattle are better fed than those belonging to the professional *gujars*, because their owners wish to get milk of good quality irrespective of the expenses incurred. The typical ration allowed to such a cow yielding about 7 seers of milk per day has been estimated to be :—

	lbs.
Wand (ground gram)	4
Chhillar (gram husk)	2
Chokar (bran)	4
Khal (oil cake)	2

Privately owned cows when running dry receive about one-third of the above ration of concentrates, which are mixed wet with about 8 to 10 lbs. of wheat chaff (*turi*), and the whole feed thus prepared is commonly known as *gotawa*, *i.e.*, cow-feed.

Green and succulent feeds have a very favourable influence on milk secretion; they are cooling, slightly laxative, aid appetite and generally keep the milch animals in good condition. The availability of green fodders varies in different seasons; maize, *chari* and *jawi* are among the most important. Green maize is available from June till the beginning of December, *chari* from July to September, *jawi* and green wheat from the end of December to March and April. *Chari* is a cheap fodder given to cattle practically throughout the year either in green or dry form. Green fodders are rather scarce from the end of November to the beginning of March and also in May and June. In these months of the year cattle generally lose condition, their flanks appear hollow and their coats coarse. If *zemindars* would learn to save enough green fodder in the form of silage, green and succulent fodders would be available to the milch cattle throughout the year. The table on the next page shows the order of feeding green fodders followed by the *gujars* from month to month.

The *gujars* are usually tempted to purchase low quality foods for their animals because of their low price. They often purchase mouldy and decomposed bran and stale *chapatis*, and unmarketable and weathered grains from the bazar. In fact, they seem to think that 'anything will do for cattle.' More often than not such food is found to be dear in the long run, when allowance is made for deterioration in the animals who go off feed, lose condition and stop yielding anything for some days owing to their having taken in damaged and inferior foods. This notion of false economy further tells seriously on the productive capacity of the animals.

Table showing Fodders Used in Different Months.

Month.	Green fodders available.
Magh (Jan.-Feb.) ..	*Jawi* and wheat mixed with dry *jowar*; turnips; leaves of cabbage.
Phagan (Feb.-March) ..	*Jawi*; wheat; *senji* mixed with dry *jowar*; leaves of cabbage (rather sparingly).
Chet (March-April) ..	*Jawi*, *senji* (mixed with wheat chaff).
Baisakh (April-May) ..	Dry *jawi*; wheat chaff; *kangni*.
Jeth (May-June) ..	*Kangni*; *china*.
Har (June-July) ..	*Makki*, green.
Sawan (July-August) ..	*Chari*; grass; *makki*.
Bhadon (August-Sept.) ..	*Chari*; grass.
Asoj (Sept.-Oct.) ..	*Bajra*; *chari* and grass.
Katak (Oct.-Nov.) *Maghar* (Nov.-Dec.) }	Maize mixed with dry *chari*.
Poh (Dec.-Jan.) ..	Dry maize; *kamad*; turnips; dry *chari*; dry *jowar*.

A sensible cattle feeder should be able to assess the real cash value of the large number and variety of foods at his disposal. Being illiterate and served with little useful propaganda cattle owners have little knowledge of the matter. With them economical feeds are those which sell cheap in the bazar, irrespective of quality, nourishing capacity or palatability. In short, the whole system of feeding milch cattle is haphazard, unsystematic and defective. The results are obvious and need no emphasis: many animals are let loose in the streets and bazars to pick up what they can—a dirty rag, a piece of paper or a banana peel—and are then expected to return home to yield milk!

Sudden changes in food according to the availability of cheap fodders in different seasons, coupled with irregular hours of feeding, account for serious digestive troubles in milch cattle. Under such conditions milch cattle, neither in Lahore nor elsewhere, can be expected to thrive and yield large amounts of rich milk or bear healthy calves.

Practical experience and experimentation in Western countries and in India have shown that milk production is dependent both in quality and quantity upon the following:—

1. Milch cattle should be well-bred and carefully selected to deal competently with a satisfactory and balanced ration. In other words, a cow or a buffalo meant for milk must be capable of converting economically most of her feed into milk of good quality. An inherently unthrifty animal will never do that, however scientific and sound her feeding may be.

2. Feeding must be scientific, economic, clean and sound to meet all her requirements.

3. The oversight of such animals should be in the hands of people with a good knowledge of the art of their management. They should possess powers of observation to note whether the animals are doing well.

4. The housing and tending of milch animals must be hygienic in every way.

An examination of local conditions on these points, finds them anything but satisfactory. Food given to cattle yields the maximum return only when it is well-balanced in its digestible chemical constituents. It may not be without interest here to study how the feeds used by *gujars* and private owners compare in their nutritive values.*

A cow, when in full milk, requires about one-tenth the weight of her body per day in food. On an average the live-weight of our cows is about 650 lbs. or nearly 8 maunds. Such a cow would require 65 lbs. or 32½ seers of a judicious mixture of grasses and clovers or its equivalent in other food stuffs, per day, of which 75 per cent. should be water and 25 per cent. dry matter. Out of the 25 per cent. dry matter, only three-fifths are digestible and assimilable in the body; the remainder is indigestible and got rid of in dung and urine. Out of the soluble portion, 7½ lbs. are carbohydrates, 1¼ lbs. proteins and ⅓ lb. fats. Further, a cow in lactation requires food for two purposes, to maintain the body in good health, and yield milk. The quantity of food required for the former purpose is known as 'maintenance ration' and that for the latter purpose as 'production ration.'

Two cows of average weight giving 5½ seers (11 lbs.) and 7 seers (14 lbs.) of milk, per day, respectively, testing 4 per cent. of fat, would require the following amounts of nutrients :—

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*Pages 89 to 91 are mainly based on the chapter "Balancing of Rations" in 'Feeding and Milking of Cows,' by A. C. Aggarwala.

Table showing Maintenance and Production Rations of Two Cows Examined.

Cow.	Ration.	Digestible Nutrients in lbs.		
		Proteins.	Carbo-hydrates.	Fats.
1. Giving 11 lbs. milk per day.	For maintenance ..	0·518	5·18	0·074
	For production of milk	0·594	2·64	0·231
	Total requirements ..	*1·112*	*7·82*	*0·305*
2. Giving 14 lbs. milk per day.	For maintenance ..	0·518	5·18	0·074
	For production of milk	0·756	3·36	0·294
	Total requirements ..	*1·274*	*8·54*	*0·368*

The following table shows the percentage of digestible nutrients in the various foods :—

Table Showing Percentage of Digestible Nutrients in Various Foods.

Name of Food stuff.		Digestible Nutrients in 100 Parts.		
Vernacular.	English equivalent.	Proteins.	Carbo-hydrates.	Fats.
Wand ..	Ground gram ..	15·600	50·700	3·450
Chhillar ..	Gram husk ..	..	..	..
Phhak ..	Rice bran ..	3·724	33·352	6·398
Chokar ..	Wheat bran ..	9·945	46·222	2·407
Til khal ..	Gingelly cake ..	33·910	17·000	7·400
Jowar ..	Millet, cut ..	0·242	17·305	..
Chari ..	Dry *jowar*, hay ..	1·090	52·280	0·570
Makki ..	Maize ..	7·125	67·163	3·240
Turi ..	Wheat straw ..	0·739	46·566	0·309

With the help of the above table the two typical rations given by *gujars* and private owners, may be analysed into their component digestible parts and are given in the following table :—

Table showing the Digestible Nutrients in Foods fed to Cows by Gujars and Private Owners.

Cow.	Daily food allowed.	Digestible Nutrients in lbs.		
		Proteins.	Carbo-hydrates.	Fats.
1. *Gujar's* cow giving 11 lbs. of milk per day.	*Wand*—4 lbs. ..	0·624	2·280	0·148
	Phhak—6 lbs. ..	0·223	2·001	0·383
	Chhillar—1¼ lb. ..	..	..	..
	Jawi—30 lbs. ..	0·072	5·191	..
	Chari—10 lbs. ..	0·109	5·228	0·057
	Total ..	1·028	14·700	0·588
	Total requirements ..	1·112	7·820	0·305
	Difference ..	*—0·084*	*+6·880*	*+0·283*
2. *Gujar's* cow, when dry.	*Jawi*—30 lbs. ..	0·072	5·191	..
	Chari—10 lbs. ..	0·109	5·228	0·057
	Total ..	0·181	10·419	0·057
	Total requirements ..	0·518	5·180	0·074
	Difference ..	*—0·337*	*+5·239*	*—0·017*
3. Owned privately and giving 14 lbs. milk per day.	*Wand*—4 lbs. ..	0·624	2·280	0·148
	Chhillar—2 lbs. ..	..	..	..
	Chokar—4 lbs. ..	0·397	1·848	0·096
	Khal—2 lbs. ..	0·678	0·340	0·148
	Turi—10 lbs. ..	0·073	4·656	0·030
	Jawi—30 lbs. ..	0·072	5·191	..
	Total ..	1·844	14·315	0·422
	Total requirements ..	1·274	8·540	0·368
	Difference ..	*+0·570*	*+5·775*	*+0·054*
4. Owned privately and dry.	*Wand*, *Chhillar*, *Chokar*, *Khal* ⅓ of the above ..	0·569	1·489	0·139
	Turi—10 lbs. ..	0·073	4·656	0·030
	Jawi—30 lbs. ..	0·072	5·191	..
	Total ..	0·714	11·336	0·169
	Total requirements ..	0·518	5·180	0·074
	Difference ..	*+0·196*	*+6·156*	*+0·095*

From the analysis of these rations we notice that when in milk, *gujars'* cows do not get proteins in the amounts required, and when dry they are definitely underfed. On an average, the dry cows are allowed 0·181 lb. of proteins and 0·057 lb. of fats as compared with 0·518 lb. of proteins and 0·074 lb. of fats required by them in the way of their ' maintenance ' alone. They receive 10·419 lbs. of carbohydrates, *i.e.*, a little more than double their essential requirements; these are undoubtedly the most economical of all cattle foods and it may be admitted that the *gujars* give them to their cows in plenty. The excessive amount of carbohydrates makes good, to a certain extent, the deficiency in fats, but it cannot perform the functions of the proteins which alone build up muscular tissue, hide, glands, hair, etc. In brief, the ' intake ' of food in the case of the cattle owned by the *gujars* is less than the ' output,' and the whole ration remains improperly balanced. The result, therefore, is loss in weight, ill-health and early old age. The figures given at the beginning of this chapter show that in Lahore, 21 per cent. of the cows and 20 per cent. of the buffaloes are useless as milk-giving animals.

The cattle owned privately on the other hand, are generally over-fed particularly when the cows cease giving milk and consequently their requirements fall. During the dry period the ration given to them contains proteins very much in excess of their needs; and the fats and carbohydrates would nearly suffice for double their number. This is wasteful and uneconomic apart from being harmful to the health of the animals. The effect of over-feeding is that the animals begin to put on superfluous fat which undermines their capacity for breeding and milk production.

Another great deficiency in the feed of the cattle is that common salt is not given to cows regularly and in sufficient quantity, and there is a prejudice against allowing salt to buffaloes. An average cow requires at least 1 oz. of common salt daily in order to remain in the best of health and in most cases, this is not given.

What is definitely a menace to public health is not so much the deleterious food given to the cattle as the impure and dirty water which the animals drink. A clean and plentiful supply of pure and wholesome water is essential for milch cattle and above all, regularity in watering. Milch cattle in Lahore are not only kept short of water but are frequently allowed to drink dirty water from stagnant pools and foul sewage drains. This tells badly on their health and is indirectly dangerous to humans.

CHAPTER VII.

CONCLUSION.

The trade in milk is of considerable importance in a city the size of Lahore ; it is estimated that over forty lakhs of rupees are paid for milk annually, and several thousands of families derive their livelihood from handling this article. The importance of milk in diet has been frequently stressed and in a city where so many are vegetarians its value as food is of special importance. A pure milk supply does not seem to be easily secured, while the dangers from impure supplies can with difficulty be avoided. Of the 94,473 children born within the municipal area within the decade 1920-29, no less than 21,010 or 22 per cent. died within their first year and 16,425 or 17 per cent. died between the ages of one and five years.

The following table shows the comparative rates of infant mortality per 100 children born living in various countries, and in Lahore :—

*Rate of Infantile Mortality for Various Countries and Lahore.**

Country.	*Deaths below 1 year per 100 live births.*	Country.	*Deaths below 1 year per 100 live births.*
U. S. S. R (1927) ..	19·1	England & Wales (1929)	7·4
Hungary (1928) ..	17·7	U. S. A. (1926) ..	7·3
Egypt (1928) ..	15·1	Sweden (1926) ..	5·6
Czecho-Slovakia (1928)	14·6	Australia (1927) ..	5·5
Japan (1927) ..	14·2	Switzerland (1928) ..	5·4
Austria (1927) ..	12·6	Norway (1927) ..	5·1
Germany (1928) ..	8·9	India (1929)† Males	18·6
Denmark (1926) ..	8·5	India (1929)† Females	17·0
France (1927) ..	8·3	Punjab (1929)† Males	19·0
		Punjab (1929)† Females	18·2
		Lahore (1929)‡ ..	*22·2*

It is, however, not known how many children in Lahore fell victims to impure milk but the mortality from what are termed ' milk-borne '

*International Health Year-Book, 1929, published by the League of Nations.

†Statistical Abstract for British India, 1920-21 to 1929-30.

‡Lahore Municipal Health Department figure.

diseases must be high. The following figures give the total deaths within the Lahore Municipal area for different years from diseases which can have their source in impure milk :—

Deaths from certain Diseases in Lahore from 1925 to 1929.

Cause.	1925.	1926.	1927.	1928.	1929.
Tuberculosis	790	787	723	670	742
Cholera	15	5	128	19	65
Typhoid	1	29	382	546	72
Dysentery . ..	541	546	508	559	639

In the course of the investigation, it was frequently stated that the people were desirous of consuming more milk if more were available, but it is not so certain that they would pay the higher price for an assured supply of pure milk. The general run of incomes is small, and the pure article is dear when prices are compared with those in Western countries.

The following table shows the milk prices in Lahore and certain cities :—

Retail Milk Prices in Pence per Gallon in Lahore and some European Cities.

Year.	Lahore.		London.	Glasgow.	Berlin.	Hamburg.	Copenhagen.	Paris.
	Cow's	Buffalo.						
1925 :	21·1	24.4	26·0	24·3	17·2	16·3	..	..
1926 ..	19·7	23·0	26·7	24·0	15·6	16·5	23·2	..
1927 ..	19·4	19·7	26·0	23·0	16·2	16·2	21·4	14·1
1928 ..	18·7	21·1	26·0	23·7	16·5	16·5	21·4	14·3
1929 ..	19·4	22·5	26·7	25·4	..	..	22·1	15·4
1930 ..	18·3	22·5	..	..	..	..	..	..

Note.—Information regarding foreign towns is extracted from ' Milk Price Margins,' Empire Marketing Board Publication No. 51.

Rates for London, Glasgow and Copenhagen are 'Retail domicile prices,' *i.e.* price charged to domestic consumers for milk delivered in bottles to their doorstep, and cover the cost of bottling and delivery besides pasteurising and cooling.

For Berlin, Hamburg and Copenhagen shop prices are given comparable to the Lahore *kalwais*. In Lahore, it should be noted, milk is only filtered before retailing and not subjected to any other process.

Whether it is practicable to bring down the price is a matter for inquiry; the ordinary *gujar* keeps but few animals and so attempts to make his profit out of a small turnover. The poor and illiterate people who handle the milk keep to their old dirty traditions and lack both the desire and the means to improve their methods; even were the desire present, the heavy burden of debt would rob them of all initiative towards the improvement of their animals. In addition to these obstacles, there is an almost complete absence of organisation and of the savings which can be obtained from organisation. Too many people handle the milk between the cow and the consumer; means of transport are defective and there are too many persons bringing small quantities to town to make cheap carriage. When milk is plentiful there is little opening for disposal of any unsold surplus. Even were the human element less open to criticism, there would still be much room for improvement in the cattle; the cows give small quantities, and this is produced at a relatively high cost. When compared with the value of the fodder, the animals are not efficient food producers. There has been no scientific attempt to improve the breed; the mating is arranged, if such a word can be used, regardless of the milk qualities of the sires. The calves are badly fed, the cows are neglected when dry and given inferior food when in milk. The dry period is longer than in England and the owner has the trouble and expense of keeping animals which yield no return. The city *gujars* have little if any land of their own and have to purchase fodder and concentrates, often on credit at high rates of interest. Finally, the arrangements for stalling the animals allow of no provision for sanitary considerations, fresh air and ventilation.

Existing arrangements are defective and there seems to be little prospect of any improvement in the near future. There is little instruction available on the subject of milk and milk production and less effort to bring it into play; little is to be expected from the existing staff of Sanitary Inspectors unaided. Amongst the general public, there is meagre interest shown in the question of an adequate supply of pure milk, and with public opinion apathetic, there is small prospect of success for any legislation that may be enacted. There seems to be hardly any attempt at propaganda aimed at a better and wider appreciation of the importance of pure milk.

Cows vs. Buffaloes.—Within the city the milk produced is chiefly cow's, but the milk brought in from outside is mostly buffalo's. The latter animal has been rapidly increasing in popularity in the province in recent years, as the table on the next page shows, yet within the city, cows

Table giving figures of Cattle Censuses in the Punjab.

(In millions).

Year.	Cows.	Female buffaloes	Bulls and bullocks.	Male buffaloes.	Young stock.	Total cattle.	Percentage of cows to the total.	Percentage of female buffaloes to the total.
1904 ..	3·0	1·9	4·1	0·6	3·7	13·3	22·5	8·4
1909 ..	3·4	2·2	4·2	0·6	3·8	14·2	23·9	9·2
1914 ..	3·7	2·6	4·6	0·6	4·0	15·5	23·8	10·9
1920 ..	2·7	2·4	3·9	0·4	4·9	14·3	..	..
	3·0	*2·7*	*4·3*	*0·5*	*3·8*	*14·3*	*21·6*	*12·5*
1923 ..	2·7	2·6	4·1	0·4	5·1	14·9	..	..
	3·0	*2·9*	*4·5*	*0·5*	*4·0*	*14·9*	*20·1*	*14·4*
1928 ..	2·6	2·7	4·0	0·4	5·2	14·9	..	..
	2·9	*3·1*	*4·4*	*0·5*	*4·0*	*14·9*	*19·4*	*15·9*
1930 ..	2·4	2·7	3·9	0·3	4·8	14·1	..	..
	2·6	*3·1*	*4·3*	*0·3*	*3·8*	*14·1*	*18·4*	*16·8*

Note.—Before the cattle census for 1920 'young stock' was defined as 'cattle less than 2 years old.' At the 1920 census cattle not old enough to work or produce young were treated as 'young stock.' In 1923 and onwards cattle under 3 years of age have been treated as 'young stock.' As a consequence the figures for young stock since 1920 have been relatively inflated thus rendering some adjustment necessary if comparison with previous censuses are to have any value. For this purpose the 1923 census report took the average ratio of young stock to total cattle for the first three censuses and brought down the census figure for the young stock to this ratio giving a proportionate increase in the other columns so that the total remained the same. This method has been employed for the figures of the 1920, 1923, 1928 and 1930 censuses and the two results for these four censuses are given, the unadjusted figures in ordinary type and the adjusted in italics in the above table.

number 4,822 as compared with 2,275 buffaloes; the professional *gujars* and *gowalas* possess 3,119 cows and 1,174 buffaloes. For selling purposes, the cow produces milk at a higher margin of profit than a buffalo. But with the non-professional, it is the higher fat content of the buffalo's milk which brings it into favour, and in addition the animal thrives better on stall-feeding. Cows have to be kept for breeding bullocks, but in recent years there has been a marked tendency for the proportion of cows to decline.

Concerning some large cities, such as Calcutta, it is complained that fine cows are brought in when in milk and are slaughtered when dry; in Lahore the same may be true in some measure but the existence of a number of small villages in the immediate neighbourhood provides opportunity for saving the dry animals. Small cultivators are willing to take care of dry animals until they calve again; they are then returned to their owners on payment of a fee of Rs. 1/8/0 per cow and Rs. 2/8/0 per buffalo per month. Female calves may be kept by the cultivator or by the parent's owner by mutual arrangement, the price being half the estimated value. That some dry animals are slaughtered is not disputed, but it is not known what proportion of those so dealt with are capable of yielding milk again. The price paid by the butcher is so low that it could only draw animals useless for any other purpose. No butcher could afford to pay the price of a good milch cow for his purpose. There is no evidence that the milk supply is affected by slaughter.

Milch cattle in the city.—A characteristic feature of the dairy industry in Indian cities is the large number of cattle kept within the city boundaries, in close proximity to dwelling houses, and Lahore is no different from other Indian cities in this respect; quite half of the milk supply is obtained from animals kept in the city.

There are grave objections to this custom in addition to the congestion caused by the cattle. The cleanliness and the general health of the city is not improved and there is the difficulty of satisfactory grazing facilities. The only advantages obtained from the practice is that the difficulty and cost of transport are reduced and the milk can be supplied in a fresher condition, for which there always seems to be a preference. Satisfactory inspection is more easily possible where the dairies are close together. It has been suggested that the city *gujars* should be removed just outside the city boundary and this would no doubt minimise most of the evils mentioned, but in Lahore the difficulty is to find suitable land at an economic price. Wherever cattle are kept, provision should be made for satisfactory shelters

including a *pacca* floor and provision for clean water and a proper sewage disposal. There should also be proper provision for the transport and distribution of the milk. There seems to be a good deal of truth in the statement that there is considerable economic waste in the distribution of milk in most countries and Lahore is no exception in this respect. If some satisfactory organization could be developed for the collection and sale both of milk produced inside and outside the city, it would be advantageous to both buyers and sellers. At present there is almost a complete lack of organization. There are too many individual milk producing units, small in size and having no connection with each other. The large quantity of milk consumed in Lahore should make it worthwhile providing for a marketing organization. This is being done in many Western countries in some cases by co-operative marketing associations.* The organization might also have to provide for the satisfactory rearing of young cattle and the care of dry stock as well as the provision of suitable veterinary aid, the lack of which increases considerably the mortality amongst the animals.

If some satisfactory organization could be evolved the economic condition of cattle keepers would be improved without any loss to the consumer.

Feeding of Cattle.—The cost of feeding is another important factor in milk production ; *e.g.*, grazing makes it possible to produce at a low cost. In England and America, cattle are out on pasture land from April to September, *i.e.*, for about half the year and during this period practically no concentrates

*The co-operative marketing associations of fluid milk grew rapidly during the Great War in the U. S. A., and by 1928 they marketed about two-fifths of the total milk sold in the country. In 1927, 159 such associations are estimated to have marketed 11,000,000,000 pounds of milk, which sold for 325,000,000 dollars.

These co-operative associations fall into two general classes :—

(1) *Bargaining Associations.*—These are the more numerous of the two and their chief work is to act as brokers in arranging for the sale of members' milk to distributors, and the testing of milk for producers. These associations do not pay the producers for this milk, although they guarantee payment by the distributors, and receive their income from the annual membership fee and service charge on the basis of the quantity of milk sold. Their chief advantage lies in the small capital required to start them and the low cost per unit of product sold.

(2) *Operating or Marketing Associations.*—These actually handle milk and in addition do the work done by the Bargaining Associations. They enter into contracts with producers, and make payment for the milk bought. Consequently such associations require a large amount of capital to start them and are liable to suffer loss unless skilfully managed.

The retailing of milk by co-operative associations has not been as successful as wholesale marketing, because in retail business capital requirements are high relative to the volume of milk. A co-operative society that retails milk as well as sells it wholesale to other distributors is in a difficult position. If it does retail sale alone, it can accommodate a small number of producers only. Further, the retail end of the business is interested in buying milk cheap whereas the producer who sells his product wholesale, wants to secure as high a price as possible, and it is difficult to reconcile these conflicting interests.

(For a detailed study of the history and present methods of co-operative marketing of fluid milk in the U. S. A., see 'Co-operative Marketing of Fluid Milk' by Hutsel Metzar, United States Department of Agriculture, Technical Bulletin No. 179).

are fed. Out of 32 million acres of culturable land in England, 17 million are under grass, as it pays better than cultivation. In this country things are quite the reverse and since the beginning of the present century the process of converting pasture lands into arable lands has progressed rapidly in the Punjab, so that by now good pastures have become rare. The so-called ' pastures ' adjoining the villages are a travesty of language, for in most cases they are simply tracts of barren land with scanty herbage and useless shrubs. In general the Punjab seems to have outgrown the stage of setting apart large tracts of land for feeding cattle on the ' ranch system.' Even in tracts where grazing is obtainable milch cattle have to be given concentrates throughout their lactation period, on account of the inferior quality of our grasses and this considerably adds to the cost of feeding. The deficient nature of our grasses has been a common complaint with those who have had experience of Indian dairying. For instance, Mr. Matson describes the situation thus :—

" We have no roots worth speaking of ; no rich young pastures ; comparatively little green fodder ; no leguminous plants in the grass. Our commonest fodders are straws and stalks from which seeds have ripened. Our concentrates are rich but they lack the essentials found in green plants."*

Milch-cattle, however, cannot be kept on concentrates alone ; a certain amount of succulent fodder is essential for a good milk yield. For this purpose fodder is grown, but the *zemindar* does not look upon this practice with favour. An acre of fertile land, if properly cultivated, watered and manured, will produce about 250 maunds of green oats—a popular fodder crop. The same piece of land, if placed under wheat would yield about 25 maunds of wheat and 50 maunds of straw. The usual price for green oats in Lahore is 8 annas per maund, wheat Rs. 3/8/0,† and wheaten straw 12 annas per maund. The market value of an acre of land would be about the same in both cases (about Rs. 125/-), and the preference for wheat over fodder crops on the part of the *zemindar* is due to its being readily marketable for money at any time, and because it can easily be stored, and sold when rates are most favourable. In the vicinity of Lahore another factor must be taken into consideration, *viz.*, the demand for green vegetables, which are more profitable than fodder.

* ' Some Lessons regarding Cattle Breeding and Dairying in India,' by Matson, (Journal of the Central Bureau of Animal Husbandry and Dairying in India, January, 1929).

†Since 1930, the price of wheat has gone down considerably, being Rs. 2·06 per maund in 1931 and Rs. 2·26 at the harvest of 1932, in the Lahore District.

Breeding of Cattle.—The importance of breeding cannot be over-emphasized. The Royal Commission on Agriculture pertinently remarks "Given a tract of country in which fodder-growing presented no difficulty; given also suitable arrangements for transport; the third and most important factor for the success of schemes which have a good milk supply as their object, is the type of cow or buffalo used. Fodder crops raised on tillage land cannot provide cheap milk unless the animal employed is a highly efficient converter of fodder into milk."* What careful breeding and judicious feeding can achieve may be illustrated by the following figures :—

Table showing the Milk Yield of Cows and Buffaloes in Military Dairy Farms in 1912-13 and 1924-25.†

Animals giving—	No. of Cows.		No. of Buffaloes.	
	1912-13.	1924-25.	1912-13.	1924-25.
10,000 lbs. milk and over ..	..	1	..	..
8,000 to 10,000 lbs.	..	34	1	..
6,000 to 8,000 lbs.	9	116	12	25
4,000 to 6,000 lbs.	84	438	117	354
2,000 to 4,000 lbs.	834	685	778	605
Under 2,000 lbs.	1,257	233	859	124
Total No. of animals ..	*2,164*	*1,507*	*1,767*	*1,108*

Similar striking results have been obtained in the Lyallpur Agricultural College Dairy where a herd of good milch cows has been built up by selection, scientific feeding and better management. During the last 14 years the average yield of milk per head per annum has been increased fom 2,044 lbs. to 4,369 lbs.‡

Years of promiscuous breeding and imperfect feeding have deplorably lowered the milk yielding capacity of Indian dairy stock. The lengthy process of restoring milch breeds of cattle can be undertaken only be the State and rich landlords; an example of the former effort is the Hissar Government Cattle Farm and that of the latter the Jehangirabad Cattle Farm in the Multan District, both of which are doing commendable work in the Punjab. Opportunity is writ large before the Indian breeder, and much more capital, skill and persevering labour might be spent remuneratively in this direction.

*Report of the Royal Commission on Agriculture in India, p. 229.

†*Ibid.*, p. 229.

‡ 'The Lyallpur Agricultural College Dairy Farm from 1914 to 1929,' by D. P. Johnston and Kartar Singh (Journal of Animal Husbandry and Dairying, January, 1930, page 137).

Scrub bulls.—Side by side with the introduction of good bulls a thorough campaign should be made at eliminating the scrub bulls, *i.e.*, those which have grown too old to serve, bulls of inferior type and other young bulls destined to be used for draught after castration. The Veterinary Department has been busy during recent years castrating such animals, which is the readiest remedy. The process, however, needs further acceleration and should be carried out thoroughly where cattle are mostly kept for milk.

Another great evil that has to be fought is the covering of immature heifers. Figures as to the age of cows at their first calving could not be collected as *gujars* keep no such records ; but, generally speaking, quite a large number of them are covered before they are mature or their frames fully set. Such animals remain stunted in growth and become useless at an early age as the following table shows :—

*Table Showing Average Milk Yield per Lactation of Animals at Different Ages.**

Age at first calving.	Average yield per lactation in lbs.									
	1st.	2nd.	3rd.	4th.	5th.	6th.	7th.	8th.	9th.	10th.
A.—Less than 3 years. (Average for 2 cows.)	3,293	3,382	3,849	1,966	3,640	2,206	..	..	..	..
B.—Between 3 and 4 years. (Average for 30 cows.)	3,076	3,694	3.902	3,749	3,945	4,138	3,993	3,313	3,093	2,993
C.—Above 4 years. (Average for 10 cows.)	3,388	4,570	5,496	5,312	5,378	6,084	5,117	..	..	..

The evil cannot be readily uprooted, but it should abate with the education of the *gujars* who at present lack foresight and look only to their immediate gains.

* ' The Lyallpur Agricultural College Dairy Farm from 1914 to 1929,' by D. P. Johnston and Kartar Singh (Journal of Animal Husbandry and Dairying, January, 1930, pp. 136 and 137).

Cross-breeding.—Cross-breeding, though capable of effecting immediate improvements in the milk yields of cattle has its limitations in this country. It cannot be practised on an extensive scale. Firstly, cattle are primarily required for draught purposes rather than for milk, and whereas a cross-bred cow may be a boon to the dairyman, the cross-bred bullock is invariably nothing short of a bane to the *zemindar*. The economic condition of the *zemindar*, and the extent of sub-division and fragmentation of his holdings being what they are, he cannot afford to keep two distinct types of animals; one to meet his requirements of dairy produce and the other to perform agricultural operations. Secondly, cross-bred animals are more susceptible to contagious diseases, and mortality among them from such outbreaks as rinderpest and foot and mouth disease is very heavy. Further, they require more careful feeding and tending than home-bred animals, especially during summer. Thirdly, the price of foreign pedigree bulls is very high, approximately ten times that of pure Indian bulls. All these factors stand in the way of cross-breeding except in the case of a few large dairies, and the future of Indian cattle breeding lies in satisfactory selective breeding.

APPENDIX A.

*MILK—ITS COMPOSITION AND GENERAL PROPERTIES.

The term 'milk,' strictly speaking, means the fresh and clean lacteal secretion obtained by the complete milking of a healthy cow not containing any amount of colostrum and of a standard quality, unless the milk of other mammals is meant, when the class name of the animal qualifies the term, as buffalo milk, goat's milk, mare's milk, ass's milk, etc. Freshly obtained, unchanged milk is called 'whole milk,' and the milk is known as 'mixed milk' when it is obtained from more than one kind of animal. 'Blended milk,' on the other hand, is milk modified in its composition so as to have a definite and stated percentage of any one or more of its constituents. 'Skimmed milk' is milk from which a part or all of the cream has been removed. 'Pasteurised milk' is milk that has been heated at various temperatures below boiling point for a variable length of time, but sufficiently to kill most of the active organisms present, and then immediately cooled to a low temperature. 'Sterilised milk' is milk that has been heated at or above boiling point to kill all organisms present in it.

By reason of its composition, high nutritive character, and easy digestibility, milk is a very important article of diet. It is not only a natural food for infants, but a most important food for children and adults. In the case of certain diseases of human beings where nutrition is impaired, milk is prescribed as an indispensable food.

With the recent advancement of scientific knowledge one of the greatest and most striking advantages to the general public has been the possibility of detecting, with a fair amount of certainty, whether a food exposed for sale is pure or has been adulterated. Milk is extensively used and also it is specially liable to be adulterated both with innocuous and harmful substances. The fact that milk varies greatly in its composition under normal conditions, renders the detection of adulterations rather difficult.

Generally speaking, milk consists of water and certain solids in solution, in suspension or in emulsion, but in order to understand the various changes which may occur in milk and the different ways of the examination of milk, it is necessary that one should know the physical and chemical properties of milk.

Physical properties of milk.—Milk, when freshly obtained, is a white opaque fluid when seen in bulk, and has a characteristic faintly-sweetish taste and peculiar odour. The sweetness is due to its milk-sugar (lactose); the taste and odour can be best appreciated when they are absent, as in the case of heated milk which loses some of its fine flavour. Dr. Barthel has defined the taste or flavour of normal milk in the following terms, "The taste is satisfying, pleasant and somewhat sweet, and the smell is reminiscent of the animal—but not unpleasantly so."* The so-called 'cowey' odour is due

*Dr. Barthel in his 'Milk and Dairy Products.'

to some cow's manure gaining access into the milk or to the absorption of characteristic odours from the atmosphere of cow-sheds and byres. The self-evident corollary to this statement is to see that the atmosphere surrounding the milk from the time it leaves the cow until it is consumed, leaves nothing to be desired in hygienic quality—a circumstance easy of attainment and costing nothing but forethought.

The white colour is due to the calcium caseinate it contains, and the opacity is due to the same substance and to fat. Sometimes, a more or less yellowish tinge is noticeable; that is due to a pigment (lactochrome) associated with the fat of milk. This pigment is different in the milk of different animals; it is yellowish in cow's milk and red in the human milk. According to Palmer and Eckles,* the lactochrome in cow's milk is principally composed of carotin and xanthophylls, and that both these are derived from the animal's food. During the colostral period and near the end of the period of lactation, milk may acquire a saltish or bitter taste and a rancid animal-like odour. The odours vary in intensity from a slight saltish or bitter to an objectionably bitter flavour, the milk in extreme cases being quite unpalatable and unsaleable. Abnormal odours may also be a result of the growth of bacteria in milk. Further, certain aromatic feeds also impart their characteristic odour and taste to milk, such as rape, cabbage, beet, turnips, carrots, etc. The activity of the peptonising bacteria in milk may produce a bitter taste due to the production of peptones, and later a foul and unpleasant odour and taste due to decomposition. Bacilli of the coli-ærogenes group, so commonly present in the excreta of animals, may produce an unclean and even nauseating taste with a manure-like or stable-like odour, when they contaminate milk. Lactic acid bacteria render the milk sour in taste. Among the wild plants the garlic (species of Allium) is of such strong oniony flavour that the milk of cows which eat them may become quite unpleasantly tainted. For whatever purpose the milk is required, and more especially when human consumption is concerned, it is of the highest importance that the milk should be of good natural colour, of attractive flavour and of undisputed quality.

If milk is allowed to stand undisturbed for a time, its physical appearance soon changes. The cream rises to the top, forming a 'cream layer' and leaving a more or less clear layer of 'skimmed milk' underneath. The rapidity with which the cream may separate depends upon the size of the fat globules in milk, the temperature, and the density of milk plasma. The separation of cream may be hastened by the process of centrifugation in which process, the fat being lighter than the other constituents of milk, rises rapidly to the top.

The specific gravity or density of milk ranges between 1·027 to 1·040, the average being 1·032. Viscosity or stickiness of milk is manifested by the adherence of milk to the sides of a glass vessel; it depends upon the milk solids, especially the casein. The more viscous a sample of milk is, the slower the fat in it will rise to the top. Dilution of milk with water reduces its viscosity, and creaming proceeds more rapidly, a fact of which advantage is

* 'The Principal Natural Colour Pigment in Milk Fat, etc.,' by Palmer and Eckles. (Journal of Biological Chemistry, Vol. 18 (1914), p. 191).

often taken in butter-making. Further, shaking reduces viscosity and allowing the milk to stand undisturbed increases it. Cold milk has greater viscosity and cohesion than warm milk. In heated milk, viscosity may be artificially restored by the addition of a substance called ' Viscogen.'* Viscosity is increased by age, low temperature, products of fermentation and a high solid and fat content. Pasteurisation reduces the viscosity of milk and cream. In certain pathological conditions of the udder, or when certain slime-forming bacteria are present, milk may become thicker and more viscous. The 'tatte milk ' of the Norwegians is thick and slimy owing to bacterial activity, and it is usually eaten with a spoon.

The freezing point of milk is 0·54 to 0·57 degrees Centigrade lower than that of water, and is generally given as nearly 31 degrees Fahrenheit. When water is added to milk the freezing point rises. Boiled milk has a lower freezing point than raw milk.

The refractive index of milk serum varies from 1·3429 to 1·3445, and the specific heat of milk according to Fleischmann is 0·9457. Milk is not a good conductor of an electric current and whatever ability for conductivity it possesses, is due to its mineral content.

Chemical properties of milk.—Milk has been called a vital or living fluid, because it is like other body fluids in certain respects. Chemically it is composed of all the essentials of a complete food to meet the requirements of young mammals. Some of the constituents of milk are simple, others very complex in their chemistry. Some of these are in true solution, others in suspension, and still others in emulsion. The dissolved and suspended constituents are put under the term 'plasma solids,' which, on coagulation separate into milk serum and coagulum. The fat is present in an emulsified state and in the process of coagulation, casein which is normally in suspension, thickens and settles down, carrying with it the undissolved substances, and leaves milk serum in which soluble salts, lactose, certain proteids, fermens, colouring matter, etc., are present.

Broadly speaking, the various constituents of milk may be put into distinct groups of compounds. These are :—

(A). Water.
(B). Proteins.
(C). Fats.
(D). Milk-sugar or Lactose, and
(E). Mineral matter or Ash.

In addition to the above, milk contains certain other complex substances in small amounts, namely, carbon dioxide, oxygen, lecithin, cholestrin, pigment, vitamins, enzymes, leucocytes, fibrin, anti-bodies, etc., but they are not of any great importance in practical milk inspection. Sometimes traces of certain

**Preparation of Viscogen.*—Dissolve 2½ parts of granulated sugar in 5 parts of water. Slake 1 part of good rock-lime in 3 parts of water. Pour the slaked lime through a strainer to remove coarse and undissolved particles, and add to the sugar solution. Agitate the mixture occasionally for 2 to 3 hours, and allow it to settle for about 12 hours, or until the liquid becomes clear, when it can be siphoned off and used. Viscogen should be kept in air-tight containers because when exposed it absorbs carbon dioxide from the air and is weakened. Long exposure to air also darkens the solution.

volatile substances derived from food and drugs administered to the animals for therapeutic purposes may also be recovered in milk.

There are many other ways of describing the composition of milk, and not infrequently, different constituents of milk are separated into various groups to which special names are given. Roughly speaking, milk may be divided into two parts, water and total solids. Water comprises approximately 87·3 per cent. of the total, while solids make up the remaining 12·7 per cent. The solids found in milk are fat, proteids, milk sugar and ash or mineral matter and these collectively make up the 'total solids.' The sugar, proteids and ash constitute the 'solids-not-fat' or 'serum solids.' Another method of stating the composition is to divide milk into fat and 'milk serum' or 'skim-milk.' Fat comprises nearly 3·6 per cent. of the total material, while milk serum makes up the remaining 96·4 per cent. Milk serum consists of all materials found in milk excepting fat, or in other words, it contains water, proteids, sugar and ash. The best method of giving the composition of milk is as follows :—

Composition of Milk.

	Per cent.
Water	87·3
Fat	3·6
Proteins	3·9
Milk sugar	4·5
Ash	0·7
Total ..	*100·0*

The following outlines of the methods of describing the composition of milk may be useful :—

				Per cent.	*Per cent.*
(*a*). Water	..	..	..	..	87·3
Total solids.	Fat ..	..	..	3·6	12·7
	Solids-not-fat or Serum Solids.	Proteins	..	3·9	
		Sugar	..	4·5	
		Ash	..	0·7	
		Total	..	..	*100·0*

				Per cent.	*Per cent.*
(*b*). Fat	..	..	..	..	3·6
Milk-serum or Skim-milk.	Water	..	..	87·3	96·4
	Proteins	..	..	3·9	
	Sugar	..	..	4·5	
	Ash	..	..	0·7	
			Total	..	*100·0*

The relative amounts of these constituents vary greatly in the milk of different species of animals. Each species of animal has its own peculiar milk; that of animals of the same species differs a little and the milk of a single animal is of slightly inconstant quality. The milk of each species is adjusted in such suitable proportions of its constituents as is best suited for the needs of the young of that species. No exact standard for the composition of the milk of any species can be definitely fixed, and it will, therefore, be convenient to consider only the average compositions. The average composition of the milk of different species of animals and woman is given below :—

Average Composition of Milk of Different Animals and that of Human Milk.

Animal.	Specific gravity.	Water.	Total Proteids.	Fat.	Sugar.	Ash.	Total Solids.
*Mixed cow and buffalo milk ..	1·0316	81·5	4·33	8·05	5·28	0·83	18·50
Woman	1·0298	87·58	2·01	3·74	6·37	0·30	12·42
Cow	1·0313	87·27	3·39	3·68	4·94	0·72	12·73
†[1] Indian cow ..	..	86·23	4·40	3·34	4·40	0·75	12·84
†[2] ,, ,, ..	1·0319	86·00	..	4·65	..	..	14·00
Cow's colostrum ..	1·0420	75·07	17·18	3·97	2·28	1·53	24·93
Ass	1·0320	90·12	1·85	1·37	6·19	0·47	9·88
Sheep	1·0355	83·57	5·15	6·18	4·17	0·93	16·43
Goat	1·0305	86·88	3·76	4·07	4·64	0·85	13·12
Mare	1·0347	90·58	2·05	1·14	5·87	0·36	9·42
Sow	1·0380	83·94	7·23	4·55	3·23	1·05	16·06
Bitch	1·0350	75·44	11·17	9·57	3·09	0·73	24·56
Elephant	1·0313	79·30	2·51	9·10	8·59	0·50	20·70
Camel	1·0420	86·57	4·00	3·07	5·59	0·77	13·43
Egyptian buffalo ..	1·0350	82·25	5·05	7·51	4·44	0·75	17·75
*[1] Indian buffalo ..	1·0298	81·92	4·25	7·55	4·75	0·89	18·08
*[2] ,, ,, ..	1·0308	81·60	3·89	8·60	4·52	0·78	18·40
*[3] ,, ,, ..	1·0321	82·22	4·34	8·09	4·56	0·76	17·78
*[4] ,, ,, ..	1·0260	85·13	3·92	6·07	4·13	0·75	14·87

*Figures by Meggit and Mann obtained from analyses of mixed milk of the whole Poona Dairy Herd on September 26, 1907.

†[1] Dutta and Ghose in Simpson's 'Principles of Hygiene,' 1908, p. 181. The figures refer to cow's milk in Calcutta.

†[2] Average of 134 *Sahiwal* (Montgomery cows) by the Manager, Government Military Dairy, Peshawar.

*[1] Average of 8 samples of genuine buffalo milk from Lahore, by A. C. Aggarwala.

*[2] Average of 50 samples of genuine buffalo milk (various breeds) in Bombay, by L. L. Joshi.

*[3] By J. Walter Leather at Kirkee (Poona).

*[4] Average of 129 samples of Indian buffalo milk, by Srinivasa Rao.

Chemical and physical properties of the constituents of milk.—(A). *Water in milk.*—Water in milk is nearly 87 per cent. of the total weight of milk and is chemically the same water as is found elsewhere. Its amount, however may vary from 82 to 92 per cent. according to the age of the cow, her individual character, breed, kind of food taken, her health, amount of water drunk, stage of lactation, etc. It is derived from blood and serves as a carrier of the solid constituents of milk, some of which are in solution, others in suspension and still others in emulsion, thus making them easily digestible and immediately available for nourishment without any previous mastication.

(B). *Proteins in milk.*—There are four chief proteins in milk. These are:—

1. Casein,
2. Lactalbumin,
3. Lactoglobulin, and
4. Lactomucin.

1. *Casein.* $C_{164}H_{263}N_{41}SPO_{51}$.

Casein occurs extensively in the mammary secretions. It is not a clearly defined chemical substance but probably consists of several compounds and is a nucleo-albumin containing phosphorus. It is insoluble in water and in alcohol when free, but in milk it is combined with calcium in the form of calcium caseinate. This latter compound is neutral to litmus but is acid to phenolphthalein and is responsible for the white colour of milk and part of its opacity. In milk it is not in solution but exists in a fine colloidal suspension in combination with calcium, and hence the name calcium caseinate suggested for casein as it occurs normally in milk. It forms nearly 20 per cent. of the solid contents and about 85 per cent. of the proteid content of milk. Casein is precipitated from milk by the addition of dilute acids and by certain enzymes as pepsin and rennin (chymosin).

With regard to the phenomenon of the curdling of milk or coagulation of its casein, two points are important. These are :—

(*a*). If acid is added to milk, casein is precipitated owing to the splitting up of calcium caseinate when the acid combines with calcium, and free casein, being insoluble, is precipitated in the form of a jelly-like flocculent curd. Later, this curd contracts and a fluid called 'whey' is expressed out; this is the common 'sour curdling of milk.' If lime water or a dilute solution of an alkali is added, casein will be redissolved and the acidity reduced.

(*b*). Rennet* or chymosin also curdles milk. Here calcium caseinate of the milk is split up by rennet into calcium para-caseinate and a

*Rennet extract is prepared from the fourth stomach of calves which are not fed for 12 hours before slaughtering. The stomachs are removed, washed and cleaned, and salt sprinkled on them and they are then inflated and allowed to dry in the air. After from three to twelve days they are extracted with 4 to 5 per cent. salt solution. Rennet deteriorates with age if exposed to light and warmth, and therefore, should be stored in a cool place in a well-corked coloured glass or stone bottle. It is a colloid. In rennet coagulation the presence of calcium salts, alkalies and acids, temperature, age and quality of milk are important factors to be considered.

substance called 'whey-proteid.' Calcium para-caseinate, being insoluble, is precipitated while the whey-proteid is held in solution. Certain bacteria also produce a rennet-like ferment, which is known as the ' sweet curdling of milk.' After the precipitation of casein by rennet, trypsin begins to act and this digests the curd until casein is dissolved and the mass of curdled milk is liquified. The curd formed in 'sweet curdling ' is firm and solid and not flocculent as in the case of sour curdling. This firm and solid condition of the curd is favourable for cheese-making, and for this reason, rennet is so extensively used in cheese manufacture.

The blood contains a ferment called ' anti-rennet ' ferment which inhibits the action of rennet. This substance is not present in normal milk but is liberated in inflammations of the udder, and such milk is not curdled by rennet.

Fresh milk when heated to boiling point does not coagulate. A thin membrane consisting chiefly of casein is formed on the surface but no real coagulation occurs.

Casein is formed by the secreting cells of the alveoli of the udder from the blood circulating in the organ. In the ordinary souring of milk the acid which causes the curdling is chiefly lactic acid produced by bacterial action on lactose or milk-sugar.

Casein prepared on a large commercial scale is used as a patent food for administering medicinal agents, as a base in painting materials, adhesives, plaster materials, water-proofing coloured papers, shoe polishes, imitation ivory or bone for the manufacture of billiard balls, combs, buttons, etc. About one quarter of the ordinary Cheddar cheese consists of casein.

When obtained in a pure state, cow-casein is a white, amorphous, hygroscopic powder without taste or odour. Human casein and casein from solipedes is more readily soluble than casein obtained from ruminants.

2. *Lactalbumin* comprises nearly five per cent. of the total solids of milk. It is in solution in milk and is similar to albumin in blood, but differs slightly in its chemical composition. It begins to coagulate at 65·6 degree C., and once precipitated it will not redissolve in water although it is soluble in alcohol. Lactalbumin is a tasteless white powder. It contains no phosphorus but contains twice as much sulphur as casein. It is not precipitated by weak acids or rennet. It is, however, precipitated by acid mercuric nitrate. The common cheese contains very little of albumin as it is not precipitated by rennet and remains behind in whey. Italian cheese, which contains albumin instead of casein, is made from whey.

3. *Lactoglobulin.*—Lactoglobulin originates from the disintegration of cells and is present in milk in solution. It coagulates at 75 degrees C., and is precipitated by tannin but is not coagulated by rennet. It is believed to be a carrier of anti-bodies in milk. Some investigators believe that lactoglobulin is identical with lactalbumin.

4. *Lactomucin.*—This is a bulky, greyish white, hygroscopic powder insoluble in ammonia, acetic acid and dilute mineral acids. It swells in weak alkalies. Heated with hydrochloric acid it yields a substance which reduces Fehling's solution.

Other complex proteids also exist in milk but they are not of such importance as to demand serious attention.

(C). *Fat in milk.*—The milk-fat, also called ' butter-fat ' is a mechanical mixture of several different fats and is present in milk in an extremely finely divided condition, *i.e.*, in an emulsion. Under the miscroscope it can be seen in the form of small transparent globules varying in size from 0·0016 to 0·01mm. in diameter. Jersey and Guernsey cows in England are noted for the large size of their fat globules and hence their milk is best adapted for butter-making. In India, *Gir* cows and *Murrah* buffaloes have large fat globules. Ayrshires, Shorthorns and Holsteins are noted for the smallness of the fat globules in their milk, and their milk is, therefore, best for cheese-making and market purposes. Hariana cattle have small sized fat globules. The size of the fat globules depends much upon the breed, stage of lactation and feed of the animal ; in goat's milk they are relatively small. During the first few months of milking, the fat globules are large but few ; towards the end of the period of lactation they become smaller but more numerous.

The specific gravity of milk-fat on an average is 0·91, and therefore, when milk is allowed to stand undisturbed, the fat globules rise to the top forming a layer called ' cream layer. ' When cream is removed by hand or by a ' separator ' the fluid remaining behind is called ' skim milk ' or ' separated milk. ' It may be further noted that the specific gravity of the fat is lighter than any other constituent of milk. Moderately high temperatures favour the separation of fat from milk, and hence for the separator the milk is usually warmed to nearly 90 deg. F. On the other hand, higher temperatures delay and entirely prevent the formation of the cream layer ; and temperature above 158 deg. F. destroys the cream layer entirely. The cream does not rise in ' homogenised milk ' because in the process of homogenisation the fat globules are broken up into very fine particles. Such milk is said to be more palatable and digestible than ordinary milk. Normal milk-fat has a melting point between 29·5 to 36 deg. C., and freezing point between 20 to 27 deg. C.

Chemically, all fats are composed of three elements, carbon, hydrogen and oxygen, but in the different kinds of fats the proportion of these elements differs. The composition of butter-fat varies according to the breed, age, period of lactation, feed, external conditions, etc. Each fat has its own melting point, freezing point, specific gravity and other physical and chemical characteristics, and hence the physical properties of butter-fat, especially its hardness and softness, are dependent upon the proportion in which its principal fats are present. The fats are really triglycerides of different fatty acids, some of which are soluble and volatile acids, while others are insoluble and non-volatile. The former give the butter its characteristic smell or aroma, and in addition, afford a practical basis for distinguishing pure butter from other artificial fats, like mutton and beef fats, cottonseed oil, cocoanut butter, vegetable *ghi*, etc. Butter-fat usually contains from 8 to 10 per cent. of the soluble and volatile fatty acid group of fats, whereas other fats contain only

from 1 to 3 per cent. The 3·5 per cent. of fat, or thereabouts, usually present in milk is made up in the following way :—

Table Showing the Composition of Milk Fats.

(Modification of Browne's table.)*

Nature of acids entering into the composition of fats.	Fats.	Percentage.
Insoluble and Non-Volatile	Dioxystearin ..	1·04
Ditto	Olein ..	33·95
Ditto	Stearin ..	1·91
Ditto	Palmatin ..	40·51
Ditto	Myristin ..	10·44
Ditto	Laurin ..	2·73
Soluble and Volatile	Caprin ..	0·34
Ditto	Caprylin ..	0·53
Ditto	Caproin ..	2·32
Dittc	Butyrin ..	6·23

Milk-fat like other fats is insoluble in water, but is readily soluble in ether, carbon bisulphide, nitro-benzene, and acetone. In analysis of milk and fats carbon bisulphide has some advantage since it has no solvent action on the lactic acid ; but in the case of fresh milk the quantity of lactic acid is so small that ether may be used. Butter-fat is decomposed under the influence of light, superheated steam, oxygen, mineral acids and certain micro-organism when fatty acids and glycerine are produced. The latter on further decomposition gives water, soluble acids, aldehydes, etc. Milk fat also contains a small amount of lecithin, a phosphorised fat, which is the cause of fishy odour in butter on decomposition. This fact is of importance from the commercial standpoint.

(D). *Lactose or milk-sugar* ($C_{12}H_{22}O_{11}\cdot H_2O$) :—Lactose is in true solution in milk. It is the chief carbohydrate of milk and comprises nearly 38 per cent. of the total solids. It occurs naturally in the milk and in the urine of mammals at the commencement and after the close of lactation. If mammary glands are extirpated, milk-sugar disappears from the urine and this shows that milk glands are the exclusive source of lactose. It has been maintained that lactose is the only carbohydrate present in milk, and at present it is impossible to decide whether carbohydrates other than lactose really occur in milk at all. If they do, they are in minute insignificant quantities. Milk-sugar prepared from milk of different animals has practically the same properties.

* A. C. Browne, Jr., 'The Chemistry of Butter-fat,' (Journal of American Chemical Society, Vol. 21).

" It is said that milk-sugar was discovered accidentally early in the 18th century by a Swiss peasant engaged in making cheese. The cheese having been hung up in a bag to drain, a few crystals were observed by him which had been formed by the evaporation of the whey. These were shown to a druggist who predicted the great commercial importance of this article if manufactured in large quantities. In the first half of the 19th century Switzerland, Holland and Germany manufactured milk-sugar of a crude nature, but later Switzerland controlled the market. Nowadays most countries are manufacturing their own lactose." *

"Dr. Ame Pictet of Geneva University has very recently (1928) succeeded in synthesizing lactose from beta-galactose ($C_6 H_{12} O_6$) which yields beta-galactosone and water, one molecule each; and, further, one molecule of beta-galactosone reacts with one molecule of beta-glucose to yield one molecule of lactose." †

Lactose is not as readily soluble in water as other sugars, such as cane-sugar or dextrose, and therefore, its solutions are not so sweet. It is soluble in about six parts of cold, and in two and a half parts of hot water. It crystallises in rhombic prisms. To prepare lactose on a large scale, whey is evaporated to a syrupy consistency and crystals are allowed to form. It is usually sold in a white slightly sweetish powder and is used as a vehicle for drugs, for coating pills and in infant feeding. Milk-sugar is of very great importance in the dairying industry. Certain bacteria split up lactose into lactic acid and certain by-products, like hydrogen, carbon dioxide, formic acid, butyric acid, etc. In the natural souring of milk the lactic acid bacteria break down lactose to form lactic acid. The action may be represented by the following equation:—

$$C_{12} H_{22} O_{11} \text{ plus } H_2 O \text{ equals } 4\ C3\ H_6 O_3 \text{ (Lactic acid).}$$

However, the conversion is not direct for the lactose is first changed by enzymes into glucose and galactose from which the lactic acid is produced. The presence of this acid is detected by the sense of smell when it has developed up to the extent of 0·2 to 0·25 per cent. and from 0·25 to 0·3 per cent., the acid will cause the milk to taste sour. When 0·8 to 1·0 per cent. of lactic acid is formed as a result of decomposition of sugar by lactic acid bacteria, the strong acid medium becomes unfavourable for the lactic acid bacteria to live in and they cease to break down any more lactose, until some of the acid is neutralised when they will become active again. The effect of lactic acid is to sour or 'ripen' milk, and so impart a flavour to the products like butter and cheese made from it.

(E). *Mineral matter or ash in milk.*—The mineral salts present in milk are commonly spoken of as the 'ash' or 'mineral matter.' Ash is a white material left after complete evaporation and burning of a sample of milk, and is the most constant constituent of milk; and its amount ranges between 0·7 to 1 per cent.

Milk ash is composed of the following elements:—

Potassium, sodium, calcium, magnesium, iron, phosphorus, chlorine, sulphur, carbon, hydrogen and oxygen with minute traces of flourin, iodine

* Larsen and White, 'Dairy Technology,' p. 216.
† Helv. Chim. Acta, 11,209 (1928).

and silica. These elements are present in the form of compounds which are very useful for the nourishment of the young, especially for the formation of bones and teeth. Some of these compounds are soluble in water, like chlorides, citrates and some phosphates of potassium, sodium and magnesium, while a portion of the phosphates appears to be in the form of very fine particles in suspension in milk. A part of calcium and phosphorus salts are insoluble. Soldner has given the following table representing the percentage composition of the ash of milk :—

	Per cent. found in ash.
Sodium chloride	10·61
Potassium chloride	9·17
Mono-potassium phosphate	12·77
Di-potassium ,, ...	9·22
Potassium citrate	5·47
Di-magnesium phosphate	3 71
Magnesium citrate	4·05
Di-calcium phosphate	7·41
Tri-calcium ,, ...	8·90
Calcium citrate ..	23·56
Calcium combined with casein ..	5·13

The ash content of cow's milk is considerably higher than that of human milk, but the iron content of human milk is from two to three times as great as that of cow's milk. The amount of calcium in cow's milk is many times higher than that in human milk. Colostrum contains considerably more ash than normal milk.

The salts of milk are indirectly derived from food and drinking water. Sodium phosphate if given in large quantity with food, may be recovered ln milk, while sodium chloride passes through only in small quantity.

APPENDIX B.

THE VALUE OF MILK AS AN ARTICLE OF DIET.

Food is any substance or a mixture of substances which when taken into the digestive tract supplies the body with the necessary heat and energy, builds up new tissues and replaces any tissue wastes. In order that a substance may be called a 'perfect food,' it must be capable of adding the necessary elements to the body, and that it must not be injurious or be a source of a greater loss of energy than what it brings into the system. Further, all food must be clean, hygienic, digestible, palatable and well-balanced in its constituents to furnish nourishment needed by the organism and be reasonably cheap. The best food is that which produces the best physiological results with the least amount of waste at a minimum of cost, *viz.*, which furnishes the largest amount of digestible and healthful nutrients at the least cost.

Milk, properly produced under scrupulously clean and hygienic conditions, furnishes a food possessing all the qualities mentioned above.

Now, in order that a food may be a complete one for purposes of nutrition of the fluids and organs of the body and for the production of energy and heat, it must contain all the elements present in the body. For maintaining the human body the following chief classes of nutrients are necessary :—

1. *Fats, sugars, starches, etc.*—This category of compounds consists of carbon, hydrogen and oxygen in varying proportions, and mainly produces the necessary heat, fat and energy in the body. Starch is not found in milk. Fat and sugar are present in sufficient and proper quantities and exist in a condition most suitable for easy digestion, absorption and assimilation.

2. *Proteins.*—They are compounds containing oxygen, hydrogen, carbon and nitrogen with a certain amount of phosphorus and sulphur. They are mainly concerned with the building up of new tissues, like muscle, tendon, hair, blood, etc. Their subsidiary work is also to produce energy to a certain extent. The protein of the white of eggs consists largely of albumin, lean meat contains a protein compound called myosin, and peas and beans contain one called legumin. In milk casein and albumin are the principal proteins present.

3. *Mineral matter.*—The chief of these are phosphates, chlorides and other salts of calcium, potash, soda with small quantities of iron and magnesia. They chiefly produce bones and teeth and help in the metabolism of other food constituents.

4. *Water.*—This is present in sufficient quantity in milk and is essential for health and life. Roughly, about 87 per cent. of milk is water.

5. *Vitamins.*—These are substances the exact composition of which is not definitely known yet, but this much is certain that for the proper functioning of the various organs of the body and for purposes of development, nourishment and reproduction, their presence is necessary in any complete food along with other essential constituents. The vitamins are best known by the results produced in certain deficiency diseases due to their absence. At least five kinds of vitamins are now recognised and are known as A, B, C, D and E, since more satisfactory names for them are not yet agreed upon. A liberal amount of all the different kinds of vitamins needed by the human

body are present in milk. Vitamin A is present abundantly in milk, especially from cows on pasture. This vitamin seems to be largely associated with the fat of milk : therefore whole milk, cream and butter are rich in this respect. Other important sources of vitamin A are green-leaf vegetables, egg-yolk, the liver and other glandular organs of animals. Vitamin B is found in many fresh foods, but not in highly refined ones such as wheat flour, corn starch, polished rice, white sugar, etc. It is present in milk but not so abundantly as is vitamin A. Vitamin C is less widely distributed and seems to lose its special value more easily than A and B. It is furnished by certain fruits and vegetables, for examples oranges and tomatoes, and to some extent by milk. Heated milk loses this vitamin.

All the above-mentioned essentials of a complete food are present in milk in most suitable proportions, and as such, milk as an article of diet approaches nearer to being a perfect food than any other single food, and this is the reason why pure, sweet, wholesome and clean milk is preferred to every other natural food. The physiologists and medical men recognise in milk the one food for which there is no effective substitute. Milk contains the necessary chemical combinations for the organism. Experimental animal studies have shown that milk and leaves of plants occupy a unique position among the available food-stuffs in that they are so constituted as to correct, when suitable amounts are included in the diet, the defects of cereals, tubers, roots and meats. For this reason it was suggested some years ago that they be distinguished by the term ' protective foods.' Further, from the energy stand-point, in many home budgets, notable economies could be realised by replacing a certain portion of meat and other food-stuffs in the rations by an isodynamic quantity of milk, milk products and vegetables.

Almost all the milk and its manifold products in this country come from cows and buffaloes. Their milk, however, is no better than that of other animals, but, people in general are used to their taste, and further they make a good return for the feed and care which they receive. In parts of the world where cows do not thrive due to unfavourable climatic conditions, milk from other animals is used and has proved satisfactory. For example, llama's milk is used in South America, camel's milk is liked in desert countries and reindeer's milk serves as food in the arctic regions. Originally, cow's or buffalo milk was never intended by Nature for human consumption ; it was meant to be utilised solely by their young. Owing to man's skill in selective breeding, art of feeding and animal management, the productive qualities of milch animals have developed to such an extent, that cow's and buffalo milk now serves to a considerable extent as an important article of diet for man. Further, man relishes their milk the most.

For adults milk cannot be said to be a perfect food because it contains far too large a quantity of water and as such, too much bulk (8 to 12 lbs. daily would have to be consumed to obtain the necessary amount of nutrients). Further, the amount of proteins is a trifle too large in proportion to the fats and carbohydrates, and the digestive system, receiving no other food than milk, is eventually likely to lack in development, because of being unaccustomed to handle other foods digested with greater difficulty. Also, grown up persons and children past the normal nursing period need iron in greater abundance than is found in milk. The iron stored in the body of a newly

born child is enough to enable it to live for a few months on that in milk, but older children and adults need more generous supplies such as can be obtained from more solid foods, like cereals, meat, fruits, vegetables, etc. Milk, as a food for adults, therefore, is most valuable and effective when used in conjunction with other foods, more especially the more solid ones. For children, invalids and the aged it is certainly an ideal and the most indispensable food, because it supplies in a particularly convenient and usable form materials that they need.

Dr. Hyslop Thompson, Medical Officer of Health to the Herts. County Council, describes the uses of milk in illness in a small pamphlet issued by the Agricultural Education Sub-Committee of that county, in the following terms: "In certain wasting diseases, in digestive disorders, in acute diseases associated with high fever, and the nervous conditions which result from the stress and strain of modern life, milk provides a form of nourishment pleasant to take, easily assimilated and of proved value and benefit to the patient."

In 1926-27 large scale tests were carried out in schools in seven cities and towns in Scotland and Belfast under the auspices of a Committee appointed by the Scottish Board of Health to determine the nutritive value of milk for children. At each centre of experimentation four groups of children were taken, each numbering from 40 to 50 according to the size of the classes in the schools. One group received whole milk, a second group received separated milk, a third group biscuit of the same energy-yielding value as that of the separated milk and the fourth group which acted as control received no supplementary feeding. The tests began at the end of November and finished at the end of June. The 5 to 6 year old children received $\frac{3}{4}$ of a pint of milk per school day, and the 8 to 9 one pint and the 13 to 14 one and a quarter pint. The milk was given at the school. The children in the different groups at the various centres were examined at the end of the experiment and clinical observations made. Independent reports were also handed in by the headmasters of the schools. These clinical reports show that at most of the centres the children who had received milk appeared to be in better condition than those receiving no milk. It was noted that on the whole they had glossier hair and clearer complexions and held themselves more erect. The most marked improvement in the children in the milk groups was shown in children who had been in poor condition at the beginning of the test. The results of the experiment were as follows :—

(1). The addition of the milk to the diet of school children during the seven months' experimental period had been accompanied by a rate of growth as indicated by an increase both in height and weight 20 per cent. greater than that in children not receiving extra milk.

(2). This increase in rate of growth had been accompanied by an improvement in general condition of many of the children receiving milk.

(3). Separated milk is of great value for promoting growth. Its nutritive value for children would appear to be under estimated.

The place of milk in the human diet, its use as a substitute for other food and the relative value of the nutrients it contains as compared with the cost of nutrients in other foods, are not generally realised. It has been found out experimentally in America and England that an abundant supply of milk in

the dietary decreases the cost without decreasing the acceptability of it to the consumer, that the increased consumption of large quantities of milk is accompanied by a decreased consumption of other foods and that milk is not a luxury but an economical food that may well be more widely used as a means of improving the general health of the people and reducing the greater costs of animal foods. On the whole, milk is as well and even more thoroughly digested than other animal foods, because its constituents are present in suitable proportions and in an easily digestible form.

From an economical point of view milk is also one of the most advantageous nutriments; the table given below amply illustrates this.

Table Showing the Energy Value (in Calories) and Average Cost of Different Foodstuffs.

Foodstuffs.	No. of calories per seer of the product.	Price in pies per seer of the product.	Price per 100 calories.
1	2	3	4
*L. Milk	616	48	7·7
L. Roasted beef	1,632	144	8·8
L. Mutton	1,722	144	8·3
†H. Chicken	2,176	200	9·1
H. Fish	832	100	12·0
H. Cabbage, turnips (boiled) ..	128	12	9·3
L. Carrots	158	15	9·5
H. Tomatoes (fresh)	192	48	25·0
H. Lentils, peas (dried)	1,024	60	5·8
H. Eggs (average wt. 58 gms. per egg with shell)	1,254	165	13·1
L. Potatoes	294	24	8·1
L. Bread	2,386	60	2·5
H. Rice (boiled)	1,152	48	4·1
H. Oranges, lemons (fresh) ..	448	75	17·1
H. Apples, pears	640	120	18·7
H. Grapes	832	144	17·3

*L denotes that the figures given in column 2 are calculated by the author from the table given by Lucas and Leroy in 'Le Lait,' No. 1, January 1912, pp. 15-16.

†H denotes that the figures given in column 2 are calculated by the author from the table given in 'An Index of Treatment,' edited by R. Hutchinson and J. Sherren, 1926, pp. 219-20.

Note.—Figures given in column 3 are applicable approximately to the Lahore market.

From the above table it will appear that in so far as heat or energy producing values are concerned, milk is the cheapest foodstuff excepting lentils, *dals*, peas, bread and rice, and curiously enough the poor class people who cannot afford to purchase milk in India live exclusively on these latter still cheaper foodstuffs.

APPENDIX C.

EXISTING LEGISLATION REGARDING MILK SUPPLY IN THE PUNJAB.

In this section it is proposed to examine the existing legislation on milk and to see where it has failed in its object of bringing about a pure and wholesome supply.

Milk and milk products, like curd, butter, *ghi* and *khoya*, are used all over India and more particularly by the upper and middle classes in the Punjab, while *lassi* or buttermilk, has been termed the " national drink " of the Punjabi. The milk trade of Lahore, like other Indian cities, is of considerable magnitude. The daily supply is about 99,000 lbs. and at two annas a pound, its value exceeds Rs. 12,000 or about 45 lakhs of rupees per year. With milk assuming such an important position in the daily life of the people, this report is a deplorable testimony to the wretched conditions prevailing in the whole of the milk business.

That the public is largely to blame for these conditions is conceded, but here we are only concerned with the laws and regulations that have been enacted from time to time to prevent the very practices which were found rampant everywhere.

The existing enactments regulating the housing of milch cattle, milk production, handling and distribution appear to be incomprehensive and, it would seem at places, confused if not contradictory. Thus the Punjab Municipal Act of 1911 contains no clause which is directly applicable to the sanitary construction or inspection of cattle-sheds, dairies, milk shop premises of *gujars* and *gowalas* or the securing of a clean and pure supply of milk; those sections of the Act which may be said to apply indirectly are :—

SECTION 115 enacts for general sanitary purposes that, " Should the owner (part-owner) or occupier of any building or land suffer the same to be in a filthy unwholesome state, the committee may, by notice, require him within twenty-four hours to cleanse the same or otherwise put it in a proper state and thereafter to keep it in a clean and proper state and if it appear to be necessary for sanitary purposes to do so, may at any time by notice direct the occupier of any building to lime-wash or otherwise cleanse the said building inside and outside in the manner and within a period to be specified in the notice," and SECTION 115-A (added by section 28 of Punjab Act II. of 1923) lays down that " The committee may by notice require the owner or occupier of any land on which cattle or other animals are habitually tethered to have the same properly paved or drained or both."

SECTION 147: " Whoever keeps any swine in disregard of any orders which the committee may give to prevent them from becoming a nuisance or keeps any other animal so as to be injurious to the health of the inhabitants or so as to become a nuisance, shall be punishable with fine which may extend to five rupees for every day after the first during which the offence is continued."

SECTION 148: " Whoever feeds or allows to be fed any animal which is kept for dairy purposes or may be used for food on deleterious substances, filth or refuse of any kind, shall be punishable with fine which may extend to fifty rupees."

SECTION 150: "(1). Whoever sells, to the prejudice of any purchaser, any article of food or drink which is not of the nature, substance or quality of the article demanded by such purchaser shall be punishable with fine which may extend to one hundred rupees:

Provided that an offence shall not be deemed to be committed under this section in the following cases, that is to say—

(*a*). Where any matter or ingredient not injurious to health has been added to food or drink in order to the production or preparation of the same as an article of commerce in a state fit for carriage or consumption, and not fraudulently to increase the bulk, weight or measure or conceal the inferior quality thereof;

(*b*). Where food or drink is unavoidably mixed with some extraneous matter in the process of collection or preparation.

(2). In any prosecution under this section it shall be no defence to allege that the vendor was ignorant of the nature, substance or quality of the article sold by him, or that the purchaser, having bought such article only for analysis, was not prejudiced by the sale:

(Provided that this section shall not apply to those areas to which the Local Government has directed or may direct that the Punjab Adulteration of Food Act, 1919, * shall apply)."

SECTION 188 (*h*) empowers local bodies to make bye-laws to "render licences necessary for using premises as stables, cow houses or houses or enclosures for sheep, goats or swine, and regulate the grant and withdrawal of such licenses."

SECTION 197 empowers the local bodies to make bye-laws to:

(*a*). prohibit the manufacture, sale or preparation or exposure for sale of any specified articles of food or drink in any premises not licensed by the committee;

(*b*). regulate the hours and manner of transport within the municipality of any specified articles of food or drink;

(*c*). prohibit the sale of milk, butter, *ghi*, curd, meat, game, fish and poultry by persons not licensed by the committee;

(*d*). prohibit the import into the municipality for sale of milk, butter, *ghi*, curd, meat, game, fish and poultry by persons not licensed by the committee;

(*e*). make regulations for the grant and withdrawal of licences and the levying of fees therefor under this section:

Provided that no person shall be punishable for breach of any bye-laws made under clause (*a*) of this section by reason of the continuance of such manufacture, preparation or exposure for sale, or sale upon any premises which are, at the time of making of such bye-laws, used for such purpose until he has received from the committee six months' notice in writing to discontinue such manufacture, preparation or exposure for such sale, or such sale in such premises:

Provided further that nothing herein contained shall affect the operation of section 43 of the Punjab Laws Act, 1872, and the rules made thereunder.

SECTION 199 confers the powers on local authorities to impose penalties for infringement of bye-laws referred to in section 188 (*h*), the fine extending to fifty rupees, and when the infringement of bye-laws is continued with a further fine which may extend to five rupees for every day after the first infringement so long as it continues. In lieu of or in addition to such fine, the magistrate may require the offender to remedy the mischief so far as is within his power.

* The Punjab Adulteration of Food Act, 1919, has since been replaced by the Punjab Food Act, 1929, to be referred to later on.

SECTION 201 require that "(1). No bye-law made under any section of this chapter shall come into force until it has been confirmed by the Local Government and published for such time and in such manner as the Local Government may prescribe in this behalf.

(2). The Local Government may cancel its confirmation of any such bye-law and thereupon the bye-laws shall cease to have effect."

Again, the Punjab Pure Food Act of 1929, which repealed the Punjab Adulteration of Foods Act of 1919, contains important direct enactments relating to '*banaspatine*' and '*charbini*,' and only passing indirect references to milk, as one might construe from the definition of 'food' given in section 3 (*c*) as including.

"Every article of food or drink used by man other than a drug and any article which enters into the composition or used in the preparation of any such article and also includes flavouring and colouring matters and condiments."

SECTION 4 of the Act defines the meaning of adulteration thus: "For the purpose of this Act any food shall be deemed to be adulterated—

(*i*). If it contains or is mixed or diluted with any substance which diminishes in any manner its nutritive or other beneficial properties as compared with such food in a pure and normal state or which in any other manner operates or may operate to the prejudice or disadvantage of the purchaser or consumer;

(*ii*). If any substance or ingredient has been extracted or omitted therefrom, and by reason of such extraction or omission the nutritive or other beneficial properties of the food as sold are less than those of the article in its pure and normal state, or the purchaser or consumer is or may be in any other manner prejudiced thereby;

(*iii*). If it contains or is mixed or diluted with any substance of lower commercial value than such food in a pure and normal state;

(*iv*). If it does not comply with the standard prescribed by any rules made under this Act."

SECTIONS 5 and 6 refer to the appointments of Public Analyst and Inspectors, respectively.

SECTION 7 "(1). An Inspector may—

(*a*). at such reasonable times as may be prescribed enter into and inspect any place ordinarily used for the sale of food or where there is any food which he has reasonable ground for believing to be intended for sale;

(*b*). inspect any food, found in any such place or in any other place to which the public has access, which he has reasonable ground for believing to be intended for sale;

(*c*). seize in such manner as may be prescribed any food, so found, which is or appears to be injurious to health; and

(*d*). destroy in such manner as may be prescribed any food, so found, which is decayed or putrefied."

(2). On seizing any food under clause (*c*) of sub-section (1) or taking possession of any food with a view to destroying it under clause (*d*) the Inspector shall immediately tender to the person from whom he seizes or takes possession of such food a receipt in such form as may be prescribed.

(3). Any person claiming anything seized under clause (*c*) of sub-section (1) may within such time as may be prescribed complain thereof to any magistrate of the first or second class having jurisdiction at the place of seizure who, after making such enquiry as he may deem necessary, may either confirm or disallow such seizure wholly or in part or may order the article to be restored.

(4). If within such time as may be prescribed no complaint has been made, or if such seizure is confirmed, the article seized shall be confiscated, and shall be destroyed or otherwise disposed of so as to prevent its being used for human consumption.

(5). Where the seizure of any food is made in the absence of the owner of the thing seized or of his agent, the Inspector making the seizure shall forthwith give notice in writing of the seizure to any person whose name and address are attached to the thing seized or are otherwise known to the Inspector as the name and address of the owner of the thing seized, or of the agent of such owner:

Provided that such address is in the Punjab.

(6). Any person who obstructs any Inspector in the exercise of his powers under this section shall, on conviction by a magistrate, be punishable with fine which may extend to five hundred rupees.

SECTIONS 8, 10 and 11 lay down powers of the Inspector to demand, select and take samples of any foods, the method of sampling and the manner the samples are to be dealt with by the Public Analyst for submitting a Certificate of Analysis. According to SECTION 9 any person, in payment of the prescribed fee, may have a sample of food examined and analysed.

SECTION 13 states "(1). No person shall—

(*a*). sell any adulterated food unless he has complied with such rules as may be prescribed in this behalf;

(*b*). sell any food in any package which bears or has attached thereto any false or misleading statement, word, brand, label or mark purporting to indicate the nature, quality, strength, purity, composition, weight, origin, age or proportion of the article contained in the package or of any ingredient thereof;

(*d*). sell any food containing any substance the addition of which is prohibited by rules made under this Act, or containing a greater proportion of any substance than is permitted by such rules;

(*e*). sell any food under the name of "*ghi*" or any equivalent term with or without the addition of any other word to such name unless such food is derived solely from milk fat;

(*g*). sell any food which is unfit for human consumption.

Sub-section (5) under this section lays down penalties for selling foods in contravention of sub-section (1)."

According to SECTION 14 "(1). No place shall be used—

(*c*). as a butter or *ghi* factory, that is to say, premises in which by way of trade butter or *ghi* is blended, reworked or subjected to any other treatment but not so as to convert it into any substance other than butter or *ghi*, as the case may be; except under license to be granted in such manner as may be prescribed:

Provided that the Local Government may exempt from the operation of this section any premises or class of premises described in clause (*c*),

(2). No place shall be used as a butter or *ghi* factory if it forms part of, or communicates otherwise than by a public street or road with, any other place which is required to be licensed under clause (*a*) or clause (*b*) of sub-section (1).

Sub-sections (3) and (4) under this section give penalties for non-compliance with sub-sections (1) and (2).

SECTION 17. "In the case of any conviction under this Act the convicting magistrate may order that any food to which the conviction relates, and which has been found to be unfit for human consumption, together with all packages or vessels containing the same, shall be confiscated and disposed of as the magistrate may direct.

SECTION 18. "When any person is convicted of an offence under this Act the magistrate may order that all fees and other expenses incident to the analysis of any food in respect of which the conviction is made shall be paid, by the person convicted, in addition to the fine, if any, to which he may be sentenced, and the amount of such fees and expenses may be recovered as if it were a fine.

According to SECTION 19. "No prosecution under this Act shall be instituted except on the complaint of an Inspector authorised in this behalf by a general or special order of the Director of Public Health or of the local authority which appointed such Inspector, as the case may be.

SECTION 20. "No magistrate of the third class shall take cognizance of any offence under this Act unless empowered by a general or special order in this behalf by the Local Government.

SECTION 21 refers to the institution of suits against Inspectors.

SECTION 22. "(1) The Local Government may make rules after previous publication for the purpose of carrying into effect the provisions of this Act.

(2). In particular, and without prejudice to the generality of the foregoing power, the Local Government may make rules for all or any of the following purposes :—

(*a*). regulating the qualifications of persons who may be appointed Public Analysts for the purpose of this Act ;

(*b*). regulating the appointment and qualifications of persons to be appointed as Inspectors under this Act ;

(*c*). prescribing the methods of analysis to be followed by Public Analysts for the analysis of any food ;

(*d*). fixing the fees to be paid in respect of the analysis of any food by a Public Analyst ;

(*e*). prescribing the conditions under which adulterated food may be sold and, if such conditions require the posting of a notice, the form of such notice ;

(*f*). prohibiting the addition of any substance, or of more than a specified proportion of any substance, to any food ;

(*g*). prescribing the standard with which any food must comply if it is not to be deemed adulterated under the provisions of section 4 ;

(*h*). prohibiting any modes of manufacture, preparation or preservation of any food ;

(*i*). securing the cleanliness and freedom from contamination of any food in the course of its manufacture, preparation, storage, packing, carriage, delivery or exposure for sale, and securing the cleanliness of places, receptacles, packages, wrappings, appliances and vehicles used in such manufacture, preparation, storage, packing, carriage or delivery;

(*j*). prescribing the mode of labelling food sold in packages ;

(*k*). prescribing the manner in which a license is to be granted under section 14 ;

(*l*). prescribing the form, and the particulars to be entered in the register required by section 15.

Sub-section (3). lays down rules for the breach of the provisions in sub-sections (1) and (2).

(4). Notwithstanding anything contained in any rule made under sub-section (1) it shall be lawful for any person, at any time within twelve months after the date of notification of such rule, to sell any food, the sale of which is otherwise lawful, if he proves that at the said date such food was part of the existing stock in trade in the Punjab of any person carrying on business there and that since the said date no act has been done whereby the said food fails to conform to the requirements of the said rule.

A perusal of these enactments shows that they are too indefinite; in fact one can hardly point to them as directly bearing upon any of the different phases of the milk industry commencing from the milch animal to the ultimate consumer, and one has to stretch them to obtain applicability. Furthermore, regulations with regard to sanitary requirements in cowsheds, dairies, milk shops, etc., and those relating to the prevention of animal diseases communicable to man through milk are not included; nor is there any reference regarding the prevention of the so-called "milk-borne diseases"; they have also the great disadvantage in that the operation of the existing enactments is not compulsory. It is also optional on the part of the local authorities in the various municipalities, notified areas and small towns to frame bye-laws under them. It is surprising to note that out of 259 local bodies in the Punjab only eight municipalities have framed bye-laws under section 188 (*h*); these are: the Lahore Dalhousie, Fazilka, Karnal, Lyallpur, Murree, Rawalpindi and Simla Municipalities.

It is important to remember that in legislation mere issue of enactments does not solve the problem; what really matters is their rigid and uniform enforcement. With regard to the effectiveness of the existing legislation one would be inclined to say that much of it is merely eyewash. For instance, it is commonly alleged that *gujars* in Lahore feed some of their milch cattle on horse dung and other deleterious food. Section 148 of the Punjab Municipal Code imposes a maximum fine of Rs. 50 for this, but inquiries made at the Lahore Municipal office show that only 13 prosecutions were made and 10 persons fined under this section during the last seven years. It may be possible that the allegation is baseless—though we are not inclined to this view—but certainly the insanitary state of the whole milk trade would seem to point to lack of enforcement of whatever laws there are on the subject. Again the safeguards for clause (*a*) of Section 197 of the Punjab Municipal Act more or less does away with its usefulness in that the responsibility of operation is left to the discretion of local bodies, which are, as a rule, slow to take advantage of the powers conferred upon them by Government. The Government review of the Punjab Municipal Annual Reports and Returns for the years 1928-29 says: "The working of the municipalities shows most forcibly that a proper civic spirit takes time to develop, and at least four out of the five divisions of the province disclose a melancholy picture." Again regarding the Lahore Municipality it says: "The penal provisions of the Municipal Act are not enforced to the grave detriment of the administration. The Commissioner of Lahore finds that the control over establishment in Lahore is as bad as it could be. Corruption is rampant in every department, and systematic frauds have been brought to light. Above half the income is expended on undue patronage and promotion to the detriment of other needs such as sanitation and lighting."

Regarding the value of milk and legislation on milk problems in the United Kingdom, the British Medical Journal for January, 1928, says:—

"Milk has been held to be the best single food containing as it does all the ingredients of a balanced diet. It is rich in vitamins and its high calcium content is in a readily usable form. For sucklings of the same species it furnishes a complete dietary, in the growing children it promotes nutrition, whether consumed by itself or as an ingredient of other foods. For adults too it is beneficial

though to a more limited extent. For all ages of life it has been generally agreed that milk is, in varying degrees, beneficial.

"A substance, so approved by current opinion, has appeared to the Legislature to merit protection.

"A number of safeguarding statutes and regulations, dealing either wholly or partly with milk, have therefore come into force in the United Kingdom within recent years. Under the Sale of Foods and Drugs Act 1899, several sale of milk regulations were made, covering both England and Scotland. Under the Public Health (Regulations as to Food) Act 1907, regulations were made with regard to milk and cream, condensed milk and dry milk, also affecting both countries. The Milk and Dairies (Scotland) Act 1914, and the Milk and Dairies (Consolidation) Act 1915 with its Milk and Dairies Order 1926, which related to England, protected milk by empowering the appointment of veterinary inspectors providing for the inspection of dairies, prescribing the method of dealing with milk of diseased cows, with infectious diseases in dairy employees and other matters. The Milk and Dairies (Amendment) Act 1922, which applied to both the countries, was the charter for graded milks and by orders made under it certified milk, grade A milk and pasteurised and other milks came into existence."

Contrasting the above with the conditions prevailing in India we cannot but quote from an article by Mr. Gulzar Singh Makhni, entitled 'Cattle Problem and Milk Supply' which appeared in the *Tribune*, dated 3rd September, 1929.

"As regards the milk supply, there is no legal standard for the purity of milk and its products. Secondly, the milk is at present produced under most insanitary conditions. Thirdly, there is unrestricted adulteration of milk and it is very difficult to get pure and fresh milk even at a high price in cities like Bombay and Calcutta. The morning trains and motor lorries bring the *gowalas* to the cities from places as far as 50 miles off. They bring the milk in uncovered pails, and in them are dipped a few fresh leaves to prevent it from spilling. During this process of transportation, this already insanitary milk becomes more insanitary through other sources. They generally add muddy water to give a yellowish tinge, thus deceiving the public who take it to be very rich stuff.

"There is no agitation to stop this; the people are callous; the municipality is sleeping; the Government is unmindful. It is a disgrace to India that there are no laws governing the sale of milk, the absence of which is one of the factors responsible for the high infant mortality. The problem, so vital to the welfare of India, ought to be tackled by our legislators without any further delay."

Perhaps a reason why the Punjab Municipal Act has failed to inspire enthusiasm in Local Bodies is in some measures due to the absence of any 'model bye-laws'; the result obviously has been a lack of uniformity in such bye-laws as these bodies have formulated. This is shown by a perusal of the bye-laws of the Lahore, Rawalpindi, Lyallpur and Fazilka Municipalities, under Section 188 (*h*) and 199 of the Punjab Municipal Act III. of 1911. These bye-laws are given below:—

*Bye-laws made by the Municipal Committee of Lahore.**

1. For the purpose of these bye-laws "stable" shall mean any place where horses, ponies, mules or oxen are kept for hire or for use with licensed vehicles or where sheep or milch-cattle are kept whose milk is sold.

* Sanctioned by the Punjab Government Notification No. 37202, dated the 15th December, 1928, to come into force within the Municipality of Lahore on the 5th day of February, 1929.

2. No person shall use any premises or part of any premises as a stable unless he has obtained license for such use from the committee.

3. Licenses for the use of any premises or part of any premises as a stable shall be issued to the owner or occupier of such premises by the Medical Officer of Health on behalf of the committee and shall be granted on the following conditions:—

(*a*). that the licensee shall not keep or permit to be kept in the licensed premises at any one time any number of animals in excess of the number prescribed in his license or of a description other than that specified in his license;

(*b*). that the licensee shall not permit any *syce* or other person to cook food in the licensed premises or to use them for human habitation; provided that a certain number of attendants to be specified in the license may be permitted to sleep in the licensed premises to prevent accidents among the animals;

(*c*). that the licensee shall provide in some convenient place a receptacle or receptacles for dung, litter and rubbish and that receptacles shall be of such form and of such material as the licensing officer may direct and shall be of a capacity of not less than 1½ cubic feet for each animal kept on the premises;

(*d*). that the licensee shall cause the licensed premises to be cleaned twice daily, namely in the morning before 9 a.m. and in the afternoon before 4 p.m. and to be washed down thoroughly with phenyle once every week, that all litter, dung and rubbish shall be removed to receptacles provided in accordance with condition (*c*) above, and that such receptacles shall be cleaned out twice daily; provided that this condition shall not apply in the case of any premises where arrangements have been made to the satisfaction of the licensing officer for daily disposal of litter, dung and rubbish, by incineration or otherwise;

(*e*). the licensee shall, if so required by the Licensing Officer, provide an incinerator of a type approved by the Licensing Officer, for the disposal of litter, dung and rubbish.

(*f*). that the licensee shall cause all interior walls of the licensed premises to be lime-washed at least twice yearly and more often if so required by the Licensing Officer;

(*g*). that the licensee shall cause all bedding to be turned over and exposed to the sun at least once a day and to be entirely changed at least twice a week;

(*h*). that the licensee shall give every facility to any officer appointed by the committee in this behalf to inspect the licensed premises and the animals kept thereon at any reasonable time;

(*i*). the licensee shall inform the Licensing Officer of any outbreak of any infectious disease among the animals kept on the licensed premises as soon as the outbreak comes to his knowledge, and shall segregate the animals affected pending the orders of the Licensing Officer;

(*j*). that in cases in which the animals kept on the licensed premises are milch-cattle, the licensee shall cause such animals to be properly washed down at least once a week;

(*k*) that for a breach of any of these conditions the license may be suspended or cancelled by order in writing to be signed by the Licensing Officer.

4. No license issued under bye-law 3 shall be transferred by the licensee to any other person except by permission of the Licensing Officer.

5. Any person who commits a breach of any of these bye-laws shall on conviction by a magistrate be liable to fine which may extend to Rs. 50 and if the breach is a continuing breach, to a further fine which may extend to Rs. 5 for every day after the first during which the breach continues and in addition any such licensee shall be liable to have his license cancelled.

Directions for Issue by the Municipal Committee for the Guidance of the Licensing Officer in Issuing License under Rule 3 of the Bye-Laws for Licensing Premises to be used as stables.

1. That Licensing Officer shall issue licenses for the use of as stables of only such premises as conform to the following conditions :—

(*a*). That the height of the premises is in no part less than 12 feet measured from the floor to the wall-plate.

(*b*). That the floor of the premises is at least one foot above the level of the open space or street on to which they open, is paved with some impervious material, and is sloped away from the head of the animals to be stabled with a gradient of not less than one in thirty.

(*c*). That the premises are so situated as to admit of their being properly drained directly into a drain or cesspool set apart for the purpose and constructed of some impervious material, and in such a way that the contents are easily removable.

(*d*). That the premises are adequately ventilated and lighted.

(*e*). That there is no opening from the premises likely to permit direct ventilation therefrom into any cooking place or place used for human habitation.

(*f*). In the case of premises to be used for milch-cattle—

(*i*). that the premises are surrounded by an open space not less than 15 feet wide, and that they are open to such open space on at least two sides ;

(*ii*). that there is provided in the open space surrounding the premises a paved space of an area equal to not less than one-seventh of the floor area of the premises, on which the cattle may be washed down ;

(*iii*). that wherever possible a water tap will be provided from the Municipal water-supply for use in the stable.

2. The Licensing Officer shall in every license specify the description and prescribe the number of animals which may be kept in the licensed premises. The number prescribed shall be such that there shall be reserved for each animal a space of not less than 12 feet in length by 6 feet in breadth such space being exclusive of any manger or any central or side drain.

3. If the licensee desires that one or more attendants should be permitted to sleep on the licensed premises to prevent accidents among the animals, the Licensing Officer shall enter in the license the number of attendants who may be so permitted which shall be such that the minimum floor space prescribed for each animal in accordance with rule 3 shall not be encroached upon.

4. Only one license shall be granted in respect of any premises, notwithstanding that such premises may be occupied by more than one person.

Bye-laws made by the Municipal Committee of Rawalpindi.

The Bye-laws of this Committee are the same as those of Lahore Committee except that the following sections though preserving the spirit are differently worded:—

3. (*d*). The licensees shall not keep or suffer to be kept on the licensed premises any litter or dung in such a situation or manner as to pollute any drinking water.

4. The licensee shall cause all the floors of the licensed premises to be made *pacca*, providing an adequate drain for the outflow of all waters.

5. License granted under rule 3 shall remain in force up to 31st March immediately succeeding the date of issue unless cancelled earlier as hereinafter provided.

6. No license issued under rule 3 shall be transferred by the licensee to any other person except by permission of the Health Officer.

*Bye-laws made by the Municipal Committee of Lyallpur.**

STABLES AND COW-HOUSES.

1. No place within the city shall be used as a stable or byre by persons trading in milk or keeping horses, bullocks or buffaloes for hire, unless licensed by the municipal committee.

2. The committee shall have power to cancel such license at any time on proof that any stable or byre is kept in an insanitary condition.

3. Any person using any place in the Lyallpur city as a stable or byre for animals kept for trading in milk or for hire without a license shall be liable to a fine not exceeding Rs. 50, or in case of continuing offence, to a further fine which may extend to Rs. 5 for every day after the first during which the offence continues.

Bye-laws made by the Municipal Committee of Fazilka.†

1. In these bye-laws the expression 'milch cattle' includes cows and buffalo-cows.

2. No person shall keep milch cattle with a view to sale of their milk, except in premises licensed for the purpose by the municipal committee or in the Fazilka *Gowshala* or in any other similar institution to which the committee may by subsequent bye-law apply this exception.

3. (I). No premises will be licensed for this purpose unless—

(*a*). adequate provision is made for the ventilation of the premises to the satisfaction of the committee;

(*b*). the premises are drained and paved to the satisfaction of the committee.

(II). The committee may also refuse to license premises of which the walls or roof are of inflammable material.

4. Subject to the conditions detailed in 3 above, the municipal committee shall grant licenses for premises for any number of milch cattle. Such licenses shall expire on 31st March of each year, and shall be subject to the following conditions:—

(*a*). The licensee shall cause all dung, refuse, etc., to be cleaned out of the licensed premises at least once a day.

* Sanctioned by the Punjab Government Notification No. 245, dated the 22nd May, 1912.
† Sanctioned by the Punjab Government Notification No. 489, dated the 31st July, 1916.

(*b*) The licensee shall not interfere with the arrangements for ventilation approved by the committee under bye-law 3.

(*c*) The licensee shall permit his licensed premises to be inspected at any time between sunrise and sunset by the President, Assistant Surgeon, Secretary, and Sanitary Inspector.

5. Any person who commits a breach of bye-law 2 and any licensee who commits a breach of any of the conditions on which his license was granted shall, on conviction by a magistrate, be liable to a fine not exceeding Rs. 50, and if the breach is a continuing breach, to a further fine which may amount to Rs. 5 for every day after the first during which the breach continues, and in addition the committee may suspend the license of any licensee who commits breach of any of the conditions of his license.

APPENDIX D.

QUESTIONNAIRES USED IN THE INQUIRY.

FORM I.

Import of Milk into Lahore.

Octroi post.....	Serial No.....
1. Time of import of milk.	1. .....
2. Name, caste, occupation and address of the owner of milk.	2. Name ..... Caste..... Religion..... Occupation..... Village..... Distance from Lahore....miles
3. Is the person bringing milk, its owner or a servant? If latter, his name and wages.	3. ....
4. Amount of milk, etc. imported. Specify whether *pacca* or standard weights are used. 1 *pacca* maund=50 seers. 1 *pacca* seer=20 chhataks.(*garwi*) 1 standard seer=16 chhataks.	4. Cow's milk..... Buffalo milk..... Goat's milk.. ..... Mixed milk.. ..... *Total* ..... *Khoya*.....Butter ....
5. Quantity of milk yielded by the cattle owned by the importer and the quantity bought from other *zemindars*.	5. His own cattle..... .. Milk bought ..... *Total* .....
6. A. No. of persons from whom milk is bought.	6. A. .....
B. Money paid to them in advance, if any.	B. Rs..... ....
C. Rate of purchase of milk.	C. Cow's milk..... Buffalo milk..... } per *pacca* seer.
7. Name, occupation and address of the person in Lahore to whom milk is to be sold.	7. ....
8. A. Rate of sale of milk.	8. A. Cow's milk..... Buffalo milk.... Mixed milk.... } per *pacca* maund.
B. When was the contract made.	B. .....

(*Continued*).

(*Concluded*).

C. Is this rate fixed for the whole year or any part thereof ?	C. .....
D. How is payment made : daily, weekly or monthly ?	D. .....
E. Advance taken from the *halwai* or dairy, if any.	E. Rs. .....
F. Amount daily deducted from this advance money.	F. Rs. .....
9. No. of times milk is brought to the city.	9. $\frac{\text{Once}}{\text{Twice}}$ per day.
10. A. Kind of conveyance used.	10. A. .....
B. Is it his own or hired ?	B. .....
C. If his own, its daily cost of maintenance.	C. Rs. .....
D. If hired, the charges paid.	D. Rs. .....
11. Kind of vessel used.	11. .....
12. Sample No. of milk, if taken.	12. .....

Date..... Signature.....

Form II.

Use of Milk.

1. (*a*). Name. (*b*). Caste and occupation. (*c*). Address.	1. (*a*)..... (*b*)..... (*c*).....
2. Monthly income.	2. Rs.....
3. Number of persons in the family.	3. Male adults..... Female adults ..... Children below 14 years..... *Total*.....
4. (*a*). Daily consumption of milk by the family. (If irregular, give the average). (*b*). Time of consumption of milk.	4. (*a*). As milk ..... As curd, etc. ..... *Total* ..... (*b*). Morning ..... Evening .....
5. (*a*). The supplier of milk (*gujar*, *halwai* or dairy.) (*b*). Address of the supplier. (*c*). Please say if you are satisfied with the supply. If not, in what way ?	5. (*a*)..... ..... (*b*)..... (*c*)..... .....
6. Rate of purchase of milk and curd.	6. Milk : Rs. ..... Curd : Rs. ..... } per seer.
7. If the family owns any milch animals :— (*a*). their number ; (*b*). price paid in their purchase ; (*c*). the amount of milk yielded daily by them.	7. (*a*). Cows.....Buffaloes..... Young stock....Total..... (*b*). Cows ..... Buffaloes..... (*c*). Cows (Morning)..... (Evening)..... *Total*..... Buffaloes (Morning)..... (Evening)..... *Total* .....
8. If any portion of the milk is disposed of, its amount and price.	8. ....
9. Daily feed allowed for animals.	9. Cows..... Buffaloes. ..... Young stock.....
10. Milker of the animal (servant, *gujar*, *gowala* or owner) ; and wages paid to the milker per month.	10. ....
11. Do your animals go out for grazing daily ? If so, for how long ?	11. ....
12. Rate per month per head paid for taking the animals out,	12. .....

Form III.

Dairies.

Name and address of dairy .....

A. 1.	When was the dairy opened ?	1. .....
2.	Who is (are) its proprietor(s) ?	2. .....
3.	Products sold by the dairy and their daily sale.	3. Milk (Morn.).....(Eve.)..... Butter (,,) ..... (,,) ..... Cream (,,) ..... (,,) .....
4.	Rate of sale.	4. Milk : Rs..... Butter : Rs..... Cream : Rs.....
5.	Number of regular customers.	5. .....
6.	Means of conveyance.	6. .....
7.	Kind of containers used.	7. .....
B. 8.	Total number of cattle owned by the dairy.	8. Cows..... Buffaloes ..... Cow calves.... Buff. calves .... Cow bulls..... Buff. bulls ..... *Total*.....
9.	Breeds of the bulls, their ages, and the prices paid for them.	9. Cow bulls..... Buffalo bulls.....
10.	Which milch animal have you found more useful—the cow or the buffalo, and in what way ? Has there been recently a tendency to replace the one by the other in your herd ?	10. ....
11.	No. of cattle in milk.	11. Cows..... Buffaloes.....
12.	Daily feed per animal and its cost.	12. Cow ..... Buffaloe ..... Young stock..... Bull .....
13.	Total monthly cost of maintenance per animal (recurring expenditure only).	13. Cow ..... Buffaloe ..... Young stock..... Bull .....
14.	Are the services of your bulls available to public ; if so, the fees charged ?	14. ....

(Continued).

(*Concluded*).

15. Does the dairy own any land for growing fodder; if so, its acreage ? 15. .....

C. 16. Quantity of milk bought by the dairy. 16. Cow's milk .... / Buffalo „ .. . / *Total* ..... Specify the number of standard chattak seers in the term 'maund' used by you.

17. Rate of purchase of milk 17. Cow ..... / Buffalo 16

18. Number of persons from whom milk is bought ? Are they producers or merely middlemen ? The approximate distance from which the milk is brought ? 18. .....

19. The amount of money given as advance and how is it realized ? 19. Rs.....

D. 20. Is the butter made from milk or from cream ? 20. .....

21. If from cream, from whom bought and at what rate ? The quantity of cream bought daily. 21. .....

22. How much milk (cream) is needed to produce 1 lb. of butter ? 22. .....

23. Other incidental expenses (labour, ice, etc.). Total costs of production of butter per lb. 23. .....

24. How is the separated milk disposed of ? If sold, at what rate and to whom ? Do you think the separated milk is ultimately passed on to the public as pure milk ? 24. .....

25. Kindly make detailed suggestions to improve the milk supply of the city regarding :— 25. .....

(1). its production ;
(2). its collection and transport ;
(3). its distribution ;
(4). miscellaneous.

Signature.....

Date.....

Form IV.

Halwais.

Important Note.—All weights given should be in terms of standard maunds (1 maund=40 seers) and not *pacca* maunds.

1.	Name of the *halwai* and address.	1. .....
2.	Quantity of milk purchased daily by him.	2. Cow's (morn.)..... (eve.) ..... Buffalo (,,) ..... (,,) ..... *Total* (,,) ..... (,,) .....
3.	Name, caste and address of the supplier or suppliers.	3. (*i*)..... (*ii*)..... (*iii*).....
4.	What portion of milk bought is produced locally and what portion imported ?	4. Cow's: locally .... imported..... Buffalo: ,, ... ,, ...
5.	Rate of purchase.	5. Cow's..... Buffalo..... } per maund.
6.	Rate of sale of milk.	6. Fresh cow's.. ..... ,, buffalo ..... Heated cow's..... ,, buffalo..... } per seer.
7.	Rate of sale of curd.	7. Rs..... per seer.
8.	Quantity of *khoya* bought daily, from whom and at what rate ?	8. Quantity..... Rs..... per seer
9.	Quantity of milk sold unheated. Quantity of milk sold heated.	9. Cow's..... Buffalo..... Cow's. .....Buffalo.....
10.	Quantity of milk converted into curd.	10. Morning..... Evening.....
11.	Quantity of milk made into *khoya* and other sweets.	11. .....
12.	How is payment made to *gujars* (daily, weekly or monthly).	12. .....
13.	When was contract with *gujars* made last and what were the terms ?	13. ....
14.	Rate of advance and the total amount advanced. How is it realized ?	14. ....
15.	How many times on an average does milk go bad on heating in a month ?	15. .....

Signature.....

Date.....

(Other particulars may be given on the reverse)

Form V.

Professional Milch Cattle Keepers.

(Translated from Urdu).

The following particulars should be obtained from each person in the Lahore Municipal area who keeps milch animals for the sale of milk :—

Name.....Father's name.....Caste.....

Address.....

No. of persons in the family { Men..... Women..... Children below 14 years..... *Total*.....

If servants are employed to look after the cattle, give number and salaries.....

Particulars of animals kept.

Kind of animals.	Total number of animals.	No. in milk.	No. dry.	*No. of calves.*		No. of bulls.	Daily milk yield.
				Below 1 year.	Above 1 year.		
							Mds. Srs.
Cows ..							
Buffaloes							
Goats ..							

Quantity of milk sold to *halwais* .....

Name and address of the *halwais*.....

Rate at which sold (per maund of 40 seers).....

Amount taken as advance from the *halwais*, with date when taken.....

Quantity sold retail.....

Rates per seer for such sales.. .....

Signature of *Darogha*.....Name of Ward .....

Date.....

GLOSSARY OF TERMS.

ADHIARA .. Literally half and half; a system where a cow when dry is given to a *zemindar* to feed and look after till the next calving, when he may either claim half the price of the animal from the owner or gain possession of it by paying the same amount.

AHIR .. A Hindu agricultural tribe of the South-Eastern Punjab.

AMAVAS .. The day preceding the moonless night, when it is customary among the Hindus to have *khir* or some other sweet preparation.

ANNA .. One-sixteenth of a rupee.

ARAIN .. A Mohammedan agricultural tribe, often found as market gardeners near cities.

ARORA .. A Hindu trading caste.

ASOJ .. An Indian calendar month—the middle of September to the middle of October.

BAHI .. Account book.

BAISAKH .. An Indian calendar month—the middle of April to the middle of May.

BAJRA .. Bulrush or spiked millet (*Pennisetum typhoideum*).

BALOCH .. Settlers from Baluchistan, who have taken to grazing and breeding of cattle.

BANASPATINE .. Any article of food, whether mixed with *ghi* or not, which is derived from vegetable fat and contains no animal fat other than milk fat.

BANDH .. A contract between the *halwai* and the *gujar* for a specified quantity of milk at a fixed rate. Such contracts run for a year and are customarily renewed in November.

BANIA .. The chief Hindu trading and shopkeeping caste.

BERSEEM .. Egyptian clover (*Trifolium alexandrinum*).

BHADON .. An Indian calendar month—the middle of August to the middle of September.

BHARWAL .. A *Jat* clan.

BHUSA .. Wheat straw crushed and broken into short lengths by trampling with bullocks during the process of threshing.

CHANGAR .. A Mohammedan tribe; usually assist in agricultural operations, such as reaping, and are exceedingly industrious.

CHAPATI .. The Indian loaf; a flat round wafer of unleavened bread.

CHAPRASI .. Office peon.

CHARBINI .. Any article of food, whether mixed with *ghi* or not, which resembles *ghi* or *banaspatine*, but contains animal fat other than milk fat.

CHARI .. Great millet (*Andropogon sorghum*); a fodder crop. See also *Jowar*.

CHAUKIDAR	.. Watchman.
CHET	.. An Indian calendar month—the middle of March to the middle of April.
CHHAN	.. Bran.
CHHATAK	.. One-sixteenth of a seer : equal to 2·057 ozs.
CHHILLAR	.. Gram husk.
CHINA	.. Common millet (*Panicum miliaceum*).
CHOKAR	.. Bran.
DAL	.. Split pulses.
DAROGHA	.. Overseer: inspector: superintendent.
DHOBI	.. Washerman caste.
DIWALI	.. The Hindu festival of lights.
DUSSEHRA	.. A Hindu festival commemorating the classical victory of Rama over Ravan.
GARWI	.. A small vessel with a fairly wide mouth; also used as a measure for milk; equal to 20 chhataks in Lahore and 21 chhataks in the neighbouring villages.
GHI	.. Clarified butter; in India used instead of lard.
GOTAWA	.. Literally 'cow-feed'; a mixture of concentrates, dry fodder and water given to cattle.
GOWALA	.. The Hindu milch cattle keeping caste.
GOWALMANDI	.. Literally, the place where milch cattle keepers forc-gather; a locality in Lahore which used to be inhabited by gowalas.
GOWSHALA	.. Charitable institution for maintaining old and decrepit cattle.
GUJAR	.. The Mohammedan milch cattle keeping caste.
GUR	.. Raw sugar in lumps; unrefined sugar.
HALWAI	.. Milk vendor; also confectioner.
HAR	.. An Indian calendar month—the middle of June to the middle of July.
HAROO MAKKI	.. Maize crop of the month of *Har*, fed to the cattle when green.
HARTAL	.. Sudden suspension of business; a common feature in India during periods of political agitation.
HINDU	.. An adherent of Hinduism; at the 1931 census there were 127,016 Hindus within the Lahore Municipal area or 31·7 per cent. of the population of Lahore.
HING	.. Asafœtida: (gum-resin from the roots of *Ferula foetida*).
ID-UL-FITR	.. A Muslim festival terminating the month of fast (Ramzan); it is customary to take *sawian* (an Indian form of vermicelli) in milk on this day.
JANAM ASHTAMI	.. A Hindu festival commemorating the birth of Lord Krishna.
JAT	.. One of the principal landowning agricultural tribes in the Punjab.
JAWI	.. Oats (*Areva sativa*).
JETH	.. An Indian calendar month—the middle of May to the middle of June.
JOGI	.. Mendicant caste.
JOWAR	.. Great millet (*Sorghum vulgare*).
JULAHA	.. A weaver caste.
KACHCHA ROAD	.. An unmetalled road.
KAMAD	.. Sugarcane.
KANAL	.. A measure of area, equal to 0·103 acres.

KANGNI .. Italian millet (*Setaria italica*).
KARAHI .. Broad iron pan for boiling milk.
KARWA CHAUTH .. A fast observed every year by married Hindu women as an occasion of thanksgiving, and praying for the continuation of their married state.
KASHMIRI .. Settlers from Kashmir.
KATAK .. An Indian calendar month—the middle of October to the middle of November.
KHABBAL .. A self propagating grass providing good grazing for cattle (*Cynodon dactylon*).
KHAL .. Oil cake given to milch cattle.
KHANNI .. A self propagating grass providing grazing for cattle.
KHASIL .. Green wheat used as fodder.
KHATRI .. One of the main Hindu trading castes.
KHAWI .. A self propagating grass (*Androgon lanager*).
KHIR .. A preparation of rice cooked in milk.
KHOYA .. Desiccated milk.
KHULLA WIHAR .. Literally: open dealings; irregular sale of milk, as opposed to *bandh*.
KUCHA .. Alley; lane.
LAHRI .. Dealer in provision for cattle.
LAKH .. One hundred thousand (1,00,000).
LALARI .. Dyer caste.
LASSI .. Butter milk.
LOON .. Common salt.
MACHHI .. Water-bearer caste.
MAGH .. An Indian calendar month—the middle of January to the middle of February.
MAGHAR .. An Indian calendar month—the middle of November to the middle of December.
MAINA .. Medick, a fodder crop (*Medica denticulata*).
MAKKI .. Maize (*Zea mays*).
MALAI .. The layer of cream when milk is heated.
MASHKI .. Water-bearer caste.
MAUND .. An Indian unit of weight; in this report taken as equal to 82 lbs.
MEHRA .. Hindu water-bearer caste.
MIRASI .. Minstrel caste; in olden days they used to wander over the countryside, singing its legends and keeping alive the memories of its heroes; at present they have come to be identified with domestic menials, common to a number of families.
MOCHI .. Leather worker caste: shoemaker.
MOGHUL .. Descendant from Moghuls who came to India during the reign of the Moghul dynasty in India.
MOHAMMEDAN .. Follower of Islam; at the 1931 census there were 238,033 Mohammedans within the Lahore Municipal area, or 59·5 per cent. of the population of Lahore.
MOTH .. A small pulse (*Phaseolus aconitifolius*).
NAI .. Barber.
NAVRATA .. Nine days preceding the festival of Dussehra.
NAZUL LAND .. Land which has become the property of Government by escheat or failure of heirs.
PACCA FLOOR .. Brick floor.

PACCA MAUND	.. A local unit of weight, equal to 50 seers or 40 garwis of milk.
PACCA ROAD	.. Metalled road.
PAISA RUPIA	.. One pice per rupee per month; a rate of interest equivalent to 18¾ per cent. per annum.
PANCH KALLIAN	.. A buffalo having the five best points, *viz.*, white sock above the fetlock on each feet, and white forehead.
PARALI	.. Rice straw.
PATHAN	.. Native of North-Western border of India.
PHAGAN	.. An Indian calendar month—the middle of February to the middle of March.
PHHAK	.. Rice husk.
PICE	.. One-fourth of an anna.
PIE	.. One-twelfth of an anna.
POH	.. An Indian calendar month—the middle of December to the middle of January.
PUNJAB ALIENATION OF LAND ACT.	An Act passed in 1900 restricting the sale of land by persons of agricultural tribes.
RAJBAHA	.. Canal distributary.
RAJPUTS	.. One of the chief agricultural tribes of the Punjab.
RAKH	.. A forest reserve.
RAMZAN	.. The ninth month of the Islamic calendar when the Muslims fast.
RUPEE	.. The Indian standard coin, now established at 1*s.* 6*d.*
SALARI	.. Gorgeously coloured turbans worn by gujars.
SARSON	.. Rape or mustard plant (*Brassica campestris*).
SAUNF	.. Aniseed or fennel (*Fœnical m vulgare*).
SYED	.. A Mohammedan tribe held in esteem because of its claim to have descended from the Prophet.
SAWAN	.. An Indian calendar month—the middle of July to the middle of August.
SEER	.. One-fortieth of a maund; 32·9 ozs.
SENJI	.. Indian clover, a fodder crop (*Melilotus parviflora*).
SHALGAM	.. Turnips.
SHRADH	.. A religious occasion commencing twenty-four days before Dussehra and lasting for a fortnight during which the Hindus make offerings to the memory of their departed elders by feeding the Brahmans and the poor.
SHEIKHS	.. A Muslim non-agricultural tribe; the term is loosely used and popular as it connotes Arabian extraction (the race to which the Prophet belonged) so that almost any Muslim can adopt it.
SIKH	.. The martial religious sect of the Punjab; at the 1931 census there were 21,010 Sikhs within the Lahore Municipal area, or 5·2 per cent. of the population of Lahore.
SUNNAT	.. Circumcision ceremony observed by Mohammedans.
SURI	.. Ground gram.
SWANK	.. Inferior millet grown on poor soil for fodder or grain (*Pannicum colium*).
SYCE	.. Groom.
TAHSIL	.. A sub-division of a district with a separate administrative staff. In the Punjab there are usually from three to five tahsils in a district.

TARKHAN	.. Carpenter.
TELI	.. Oil-presser caste.
TIL KHAL	.. Oil cake of gingelli.
TOLA	.. One-fifth of a chhatak or one-eightieth of a seer, equal to 0·41 ozs.
TONGAWALA	.. Driver of a two-wheeled hackney carriage.
TUKRI	.. Birthday of Guru Nanak, the founder of the Sikh religion.
TURI	.. Wheat straw.
TUM-TUM	.. Bamboo-cart drawn by a horse.
UPLAS	.. Cow-dung cakes ; a fuel used in simmering milk because of its smouldering heat.
VALTOHI	.. Narrow-mouthed brass vessel employed in transport and storage of milk.
WAND	.. Ground gram.
ZEMINDAR	.. Landowner ; cultivator.

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